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The Design of Gear Tooth Forms

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This article inaugurates a series on the subject of gears under three broad heads, the above title, gears in operation, and the production of gears. In this opening division conjugate tooth action is first discussed, then the involute curve, involute trigonometry, involute tooth design and finally the strength of gear teeth and their durability under load

THE subject of gearing is an old one; yet our knowledge of it is still far from complete. New and more severe requirements that gearing must meet are developing continually. New and improved materials and methods for their production are also being made available. To a great extent, the design of gear tooth profiles has become conventionalized, and many of the fundamentals of gear tooth action have been lost sight of in this process. As a result, the full benefits of the improved materials and production methods have not always been secured.

It is the purpose of this article and those that follow to solve present-day gear problems by employing fundamental principles as a foundation.

Conjugate Gear Tooth Action

THERE is an almost infinite number of forms which can be used as gear tooth profiles. The essential purpose of gear tooth profiles is to transmit rotary motion from one shaft to another. Usually the additional requirement of uniform motion also exists.

Although the involute profile is the one most commonly used today for gear tooth forms, occasions arise when some other form of profile must be employed. In addition there are also other problems than the transmission of rotary motion where a thorough knowledge of the theory of gearing assists in the most direct solution. One of such problems is the hobbing of spline shafts.

Again, in order to appreciate fully the great simplicity of the involute form, both in theory and in its production, it is necessary to have a clear understanding of the principles of conjugate gear tooth action. We will therefore consider at this time the characteristics of tooth profiles that will transmit through each other uniform rotary motion. The action between such profiles is called conjugate gear tooth action.

In essence, a pair of mating gear tooth profiles are cams, the one acting against the other to produce the desired relative motion. With certain restrictions, one profile can be chosen at random, and a proper mating profile can be developed.

As a definite example, we will now consider the action between two lever arms, the one with a pin which engages in a slot of the other, the driven member. This is illustrated in Fig. 1.

The lever with the pin is rotating with uniform motion in the direction shown by the arrow. The rate of rotary motion of the driven or slotted lever depends upon the relative lengths of a and b, as shown in the illustration. The driven lever will move b/a times as fast as the driver. If these lengths a and b are equal, and remain equal in all contact positions, the rates of rotation will also be equal.

The lengths of a and b are determined by the intersection of the normal to the mating profiles at the point of contact with the common centerline of the axes of the two levers. A normal is a line which is perpendicular to the tangent of a curve at its point of tangency. Thus the normal to a straight line is the perpendicular to it, and the normal to a circle is a radial line.

At the top of Fig. 1, position A, the distances a and b are shown as equal. Therefore at this position the rates of rotation of the two levers are equal. At position B, when the driver has moved 30 deg. from its original position, b is shorter and a is longer than originally, therefore the driven or slotted lever is moving slower than the driver. At position C, when the driver has moved 60 deg. from its original position, the length of b has become zero, while the length of a has become double its original length. At this position the driven lever has ceased to move. Further motion of the driver, assuming a sufficient length of slot in the

driven lever, would cause the driven lever to start to move in the opposite direction.

It is evident that the action between the two levers, shown in Fig. 1, does not result in the transmission of uniform rotary motion from one shaft to the other. In order to transmit this uniform motion, the relative lengths of *a* and *b* must remain constant at all operating positions of the mating profiles. This gives us the basic law of conjugate gear tooth profiles which may be expressed as follows:

To transmit uniform rotary motion from one shaft to another by means of gear teeth, the normals to the profiles of these teeth at all points of contact must pass through a fixed point in the common centerline of the two shafts.

This fixed point in the common centerline is called the pitch point. With every gear tooth form, except the involute, there is a definite pitch line or circle from which the conjugate tooth profiles must be developed. The pitch circles of mating gears must be tangent to each other. The point of tangency of these pitch circles is the pitch point. These pitch circles are of such size that if they were to drive each other by friction, they would transmit the required relative motion. The sizes of these pitch circles are inversely proportional to the rate of rotation; for equal speed these sizes are equal; for double speed, the pitch circle of the slower gear is twice the size of the faster, etc. The tooth profile may be symmetrical or unsymmetrical in respect to the pitch line; it may be all above it, or all below it, or part above and part below.

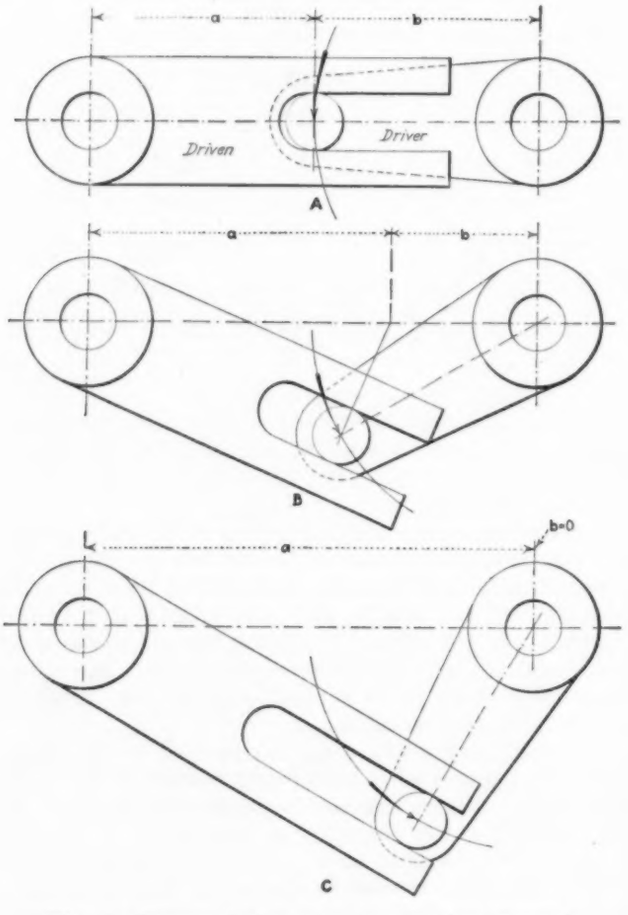


Fig. 1—Transmission of rotary action through lever arms

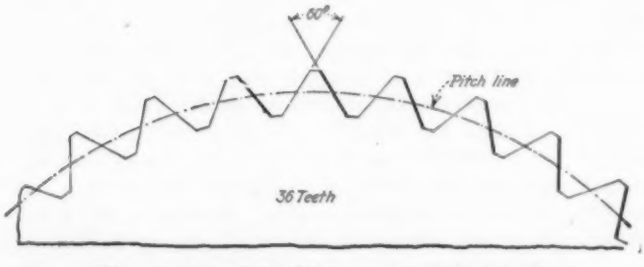


Fig. 2—Straight line gear tooth profile

As stated before, the profile of one gear may be chosen arbitrarily, and the conjugate profile for the mating gear can be developed. For every conjugate gear tooth profile there is also a basic rack form. As mating tooth profiles act together, the point of contact between them will travel along a line or path called the line of action or the path of contact. Once a pitch line has been established for any profile, a definite line of action exists, along which contact with all other conjugate profiles is made. There is a definite relation between a gear tooth profile and its line of action so that if either one is given, the other is fixed. When the tooth profile is given, it is a simple matter to construct its line of action in regard to any given pitch line, but when the line of action alone is given, it is a much more difficult task to construct the tooth profile. If, in addition to the line of action, we definitely know certain points on it that represent known angular or linear movements of the profile, this problem is greatly simplified.

In order to clarify the foregoing, we will consider several definite problems. With the exception of a few mathematical curves, such problems must be solved geometrically, or by actual layouts. In practice, these are made to a sufficiently enlarged scale to obtain the desired degree of accuracy. The following examples indicate the methods employed in making such layouts:

PROBLEM 1—*Given an arbitrary gear tooth profile, to construct its line of action.*

The arbitrary tooth profile selected is a straight line, as shown in Fig. 2. The pitch line is established at the middle of the tooth height. This gear has 36 teeth, giving an angular distance of 10 deg. between the successive teeth.

To construct the line of action, the tooth profile is rotated about its axis into several successive positions. At each position, a line through the pitch point and perpendicular to the tooth profile is drawn. The intersection of this line with its respective tooth profile is a point on the line of action. This point is where contact is made with any mating conjugate profile with the given profile in this position. After determining a series of such points, the line of action can be drawn through them. It is usually a good plan when laying out the successive positions of the tooth profile to make the intervals equal, as this greatly assists later in the construction of mating conjugate profiles.

The construction of the line of action for the selected profile is shown in Fig. 3. On the left, at *A*, is shown the construction lines only; that is, the successive positions of the tooth profile and the perpendiculars through the pitch point to each position of the tooth profile. The intersections, or contact points, are marked with heavy dots. Each position of the tooth profile is numbered for identification later. In this example, the intervals between the successive positions of the tooth

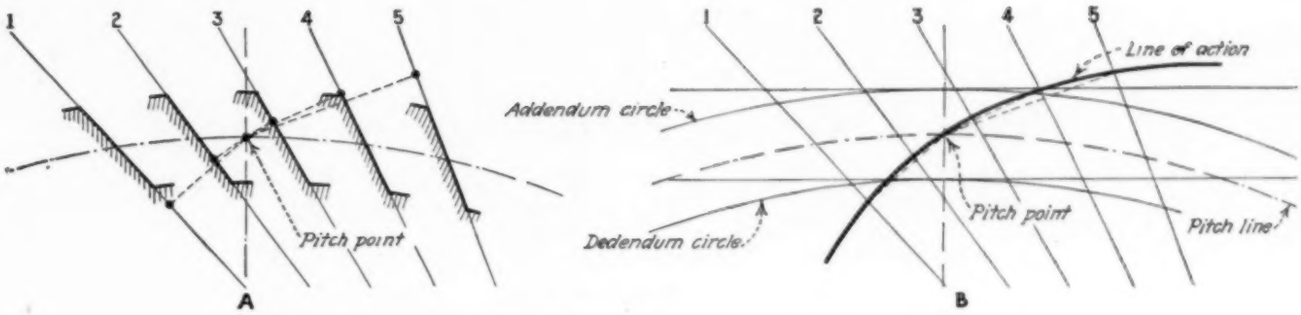


Fig. 3—Development of the line of action of a straight line gear tooth

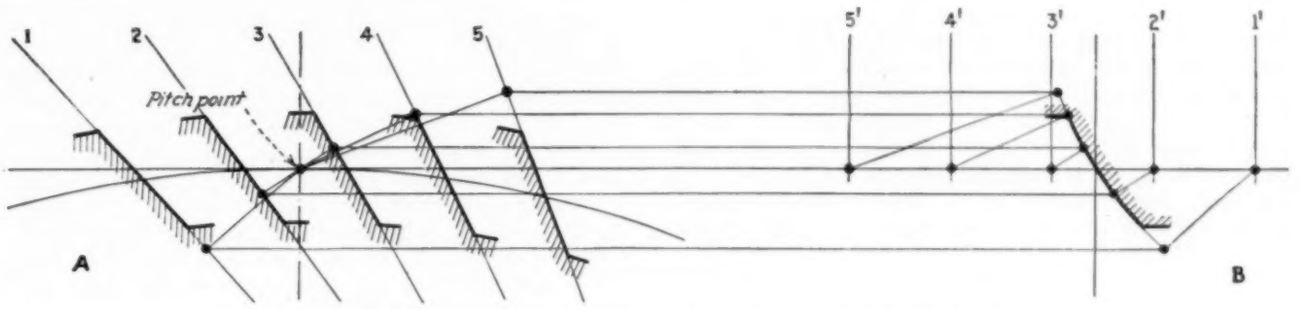


Fig. 4—Development of the basic rack of a straight-line gear tooth

profile are equal to 5 deg., or one-half the tooth spacing. In actual practice, the scale of the drawing would be greatly enlarged, and the intervals between the successive positions of the tooth profile would be much smaller.

At the right in Fig. 3 at *B*, the line of action is shown in a heavy line. A study of this illustration should make clear the method of constructing the line of action from a given gear tooth profile. When the profile is not a straight line, the tangents and normals to the curved profile must first be determined; otherwise the process is identical. Usually, the arbitrary profiles are straight lines, arcs of circles, or a combination of the two.

PROBLEM 2—*Given an arbitrary gear tooth profile, to construct the profile of its basic rack.*

The arbitrary tooth profile will be the same as before, illustrated in Fig. 2. To construct the profile of the basic rack, a series of contact points must first be determined as was done to construct the line of action. The pitch line on the rack will be a straight line. A straight line representing this pitch line is drawn, and on it are layed off intervals corresponding in length to the length of the arcs on the pitch circle of the gear between the successive angular positions of the gear tooth profile. In this example, the lengths are equal to an arc of 5 deg. on the pitch circle of the original gear. The construction is shown in Fig. 4. At *A* is shown the same layout as at *A* in Fig. 3. The intervals along the pitch line of the rack at *B* are numbered in the reverse order to the successive positions of the profile at *A* and represent the successive positions of the pitch point as the original gear is rotated to the corresponding positions. By drawing a series of parallelograms, successive points on the basic rack profile are determined. From pitch point *1'* for the rack a line is drawn parallel to the normal line to the gear profile at position *1*. From contact point *1* on the gear profile, a line parallel to the pitch line of the rack is drawn. The intersection of these two lines gives the first point of the basic rack profile. Other successive points of the basic rack profile are determined in a similar manner.

The cross hatching indicates which side of this basic rack form would be solid when meshing with the original gear. The basic rack to mesh with the conjugate gear would be reversed; that is, the cross hatching would be on the other side of the line representing the basic form. The form of this line, however, is unchanged. A study of Fig. 4 should make clear the process of constructing the basic rack form from a given profile.

PROBLEM 3—*Given an arbitrary gear tooth profile, to construct the profile of its conjugate gear tooth.*

The arbitrary tooth profile will be the same as that shown in Fig. 2. The construction of the mating conjugate tooth form is very similar to the construction of the basic rack profile, with the difference that angular intervals and radial distances are used instead of linear intervals and straight lines. A pitch diameter of the desired size is first drawn, and angular intervals corresponding to those on the original gear are layed off. If the pitch diameter of the conjugate gear is to be the same as that of the original gear, the angular intervals will also be the same on both gears. If the pitch diameter of the conjugate gear is to be twice that of the original, the angular intervals will be one-half of those on the original gear, etc. In other words, the lengths of the arcs of these intervals on the pitch lines must always be the same.

In the example shown in Fig. 5, the pitch diameter is made the same as that of the original gear. The intervals, therefore, are 5 deg., the same as before. At *A* is shown the same layout as at *A* in Fig. 3, but turned upside down for convenience in constructing the conjugate profile. The intervals on the pitch line of the conjugate gear are numbered in the reverse order to the successive positions of the profile at *A*, and represent the successive positions of the pitch point as the original gear is rotated to the corresponding positions.

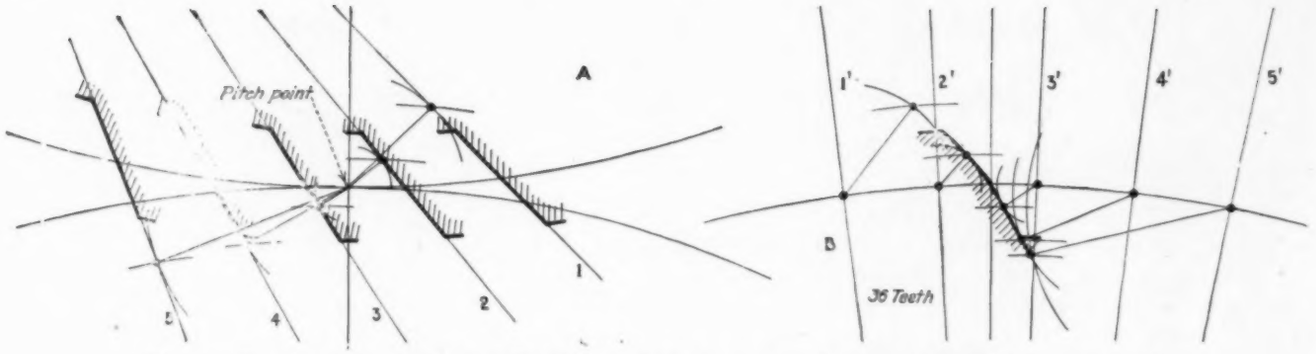


Fig. 5—Construction of the profile of a conjugate gear tooth of a straight line gear tooth

Instead of drawing a series of parallelograms as for the basic rack form, we construct a series of similar triangles to determine the conjugate gear tooth form. From pitch point *1'* on the conjugate gear an arc is drawn equal in radius to the distance from the pitch point at *A* to contact point *1*. From the center of the conjugate gear another arc is drawn equal in radius to the distance from the corresponding center at *A* to the contact point *1*. The intersection of these two arcs gives the first point on the profile of the mating gear tooth form. Other successive points of the conjugate gear tooth profile are determined in a similar manner. A study of Fig. 5 should make clear the process of constructing the conjugate gear tooth profile from any given gear tooth profile.

(To be continued)

Machine Design for a Purpose

BY ENTROPY

Of course all machine design is for a purpose and sometimes several purposes are to be served at once. There is the machine that is designed so that it will merely run, and the designer is happy to leave it there and go on to something else; there is the machine that is designed primarily for ease of manufacture; there is the machine that is designed to sell easily; another to be readily changeable for different sizes; another to be easily accessible for repair; another for interchangeable manufacture and so on.

If a machine is being built for some one special purpose, where it is likely that the first machine will be the only one, or if it is doubtful that the machine will do the work intended, for example experimental machinery, it often pays to stop designing as soon as a workable machine is laid down. If, however, the machine is simply another size of a machine that is already being produced in quantity, it usually pays to keep it on the drawing board until there seems to be nothing left in the way of refinement about which there has not already been some thought given. This seldom means that it is the easiest to manufacture, or the most easily saleable, or any one thing, but it rather means that a compromise has been reached. It means that we have come as near to giving the sales manager what he thinks he can sell as possible consistent with being able to build the machine cheaply enough so that he can sell it at all. It may also mean that we have had to leave some place rather hard to get at in case repairs are needed, but that we have made the machine less likely to give out there or anywhere else.

My own experience with engineers, particularly those who are not long away from school, is that they are very prone to look at a machine as a mere mechanical device rather than something to be sold to a customer. If the customer is also a mechanic, and is the ultimate consumer, then it is safe to design from a purely utilitarian standpoint, but if the machine is a new style of meat chopper, or a potato peeler, then the customer may condemn it solely because it is difficult to clean after using. A case that came under my eye just recently was a hair clipper intended for feminine use, which had such unattractive outlines as to make it much less saleable than it might have been had graceful curves replaced some of the straight lines.

Adjustability is another debatable point. If the machine is to be operated by a skilled mechanic there should be possibility of adjustment everywhere, as otherwise he will get little pleasure out of running it, but if it is going into the hands of a mere operator, or like an automobile, into the hands of someone who has other things he likes to do beside tinkering, then the more the machine is designed for little wear and few adjustments the better it is.

The cost of a serious accident to a worker is much more than the wages and the doctor's bill. The loss of production in the department due to the effect on the other workers, frequently runs up into hundreds of dollars. All of which makes accident-prevention work a good investment, aside from the humanitarian point of view.

In shrinking bands or tires of medium diameter, it is well to remember the railroad shop rule of $\frac{1}{64}$ in. for each foot of diameter. This allowance is approximately 0.0015 in. per in. On large railroad tires, the allowance is $\frac{1}{80}$ in. per foot of diameter, or approximately 0.001 in. per inch.

It was long ago discovered that vibration of the cutting tool shortened its life greatly. This means that we not only need a very stiff support for the tool but for the work as well. It tells why an old, light machine, can never produce as much as one that is rigid.

The automobile has done more to further the use of alloy steels than any other single agency. Think how many alloy steel gears and other parts are in use.

Maintenance of Motive Power on New England Railroads

By Ellsworth Sheldon
New England Editor, *American Machinist*

Boiler and tank work in the Readville shops—A system to salvage flues and tubes—Punching, bending, flanging and similar operations—A device to clean and test superheater units

BOILER and tank work at the Readville shops of the New Haven road are handled in a department that occupies one end of the large locomotive shop described in a previous article, and is served by the same cranes that cover the erecting floor. This crane equipment comprises two 50-ton units and three of smaller capacity, all upon one runway and available to the boiler shop. A 10-ton crane upon the same runway and another of the same capacity upon a separate runway are at the service of the boiler makers at any time.

In the department are plate-rolls, bending and flanging machines, punches, shears, radial drills, and all of the machinery and appliances of a well equipped plant for handling and working heavy steel plates of the thicknesses used in locomotive-boiler construction. The work includes every conceivable variety to be found in a railroad boiler-shop, from the most minor repair to the building of new boilers and locomotive tenders.

All of the work upon tender trucks that does not involve wheels and axles is done here, and in no other department are the autogeneous welding processes of greater service. The oxyacetylene torch is used for cutting and welding upon tanks and trucks, while the electric arc is applied to boiler work wherever its use is allowable.

In Fig. 1 is shown a corner of the shop where the sheets are laid out preparatory to the punching, flanging, bending, drilling and other operations through which they must pass on the way to become parts of a boiler. The work is done with chalk-line, straightedge, templets, etc.; transferring from a drawing or reduced layout, the outline of the sheet and the intersections to locate the bolt, flue and other holes that are to be made in them. When the lines have been laid on the steel, the intersections that represent holes are deeply prick-marked with punch and hammer, and a circle is roughly drawn around each with chalk so that the operator of punch or drilling machine will not have to hunt for them.

Punches, drills, reamers and trepanning tools are used to make the holes in the steel sheets. For the punching operation, shown in Fig. 2, a sheet is suspended from a jib crane by means of a chain block, in such a way as to be practically in balance. The block enables the helper to make minor adjustments in the height of the work from time to time, and the fact that the heavy sheet is practically in balance renders it comparatively easy to manipulate. Each hole is located with reference to the die by entering the conical pilot of the punch in the deep prick-mark made when the sheet is laid out.

The holes in the flue sheets for the smaller flues, or tubes, are punched about 1⅛ in. in diameter and are then reamed to size under a radial drilling machine. Larger flue holes are first drilled at the intersection

The concluding article.

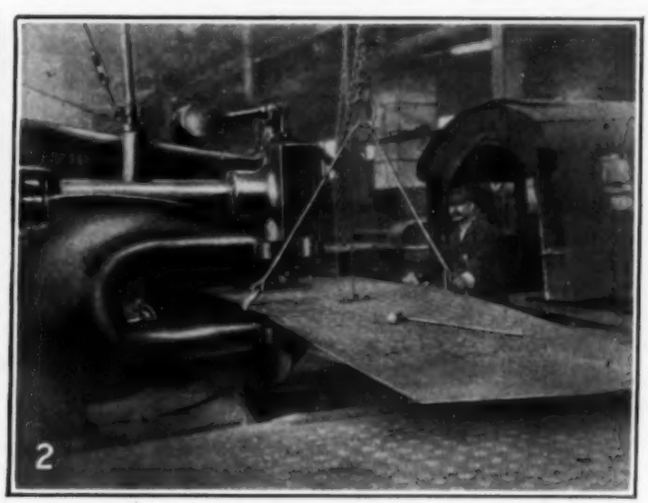
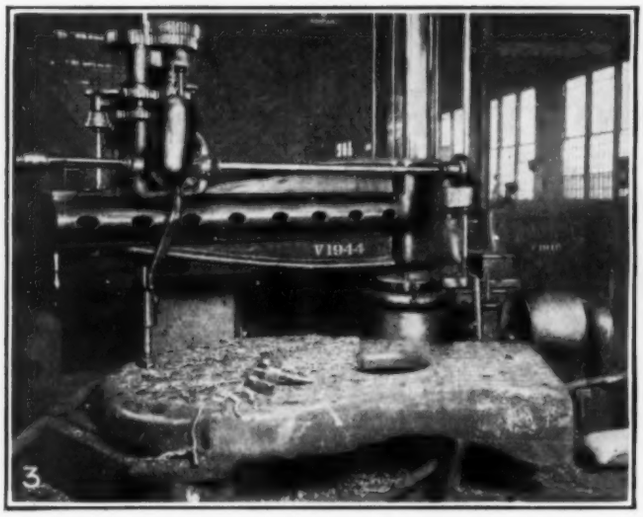


Fig. 1—Laying out a sheet for a boiler. Fig. 2—Punching staybolt holes in a firebox wrapper-sheet



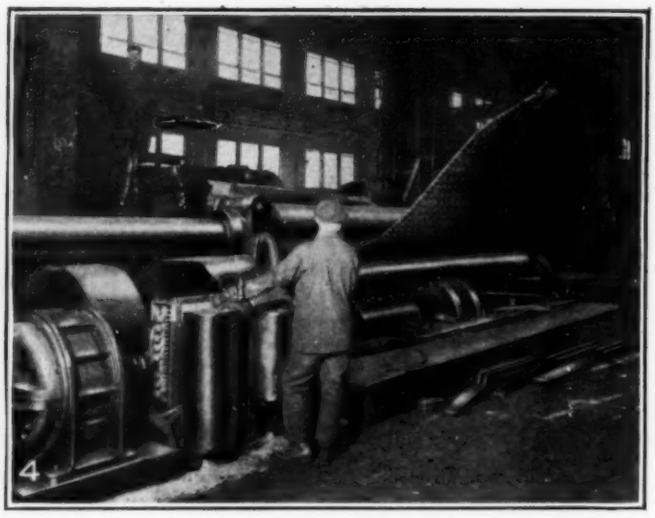


Fig. 3—Reaming flue holes on a radial drilling machine. Fig. 4—Rolling wrapper sheet for firebox

to take the pilot of a trepanning tool—or flue-hole-cutter, as it is called in the shop—and the metal is then cut out to size with this tool. Fig. 3 shows a flue sheet under the radial, with the reamer at work in the small holes. A trepanning tool is lying upon the sheet.

A wrapper sheet may be seen in Fig. 4 in the large rolls where it is being bent into shape to form a part of a new firebox. The small holes in this sheet are punched, and after the firebox has been located in the boiler of which it is to become a part, the holes are line-reamed for the staybolts. An air motor is used to operate the reamer.

The pneumatically-operated flanging machine shown in Fig. 5, is brought into service to turn down the

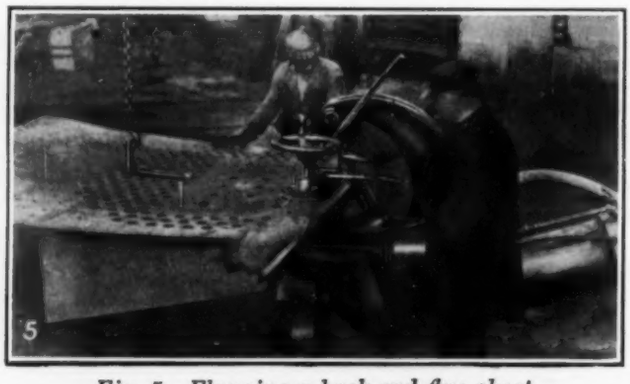


Fig. 5—Flanging a back-end flue sheet

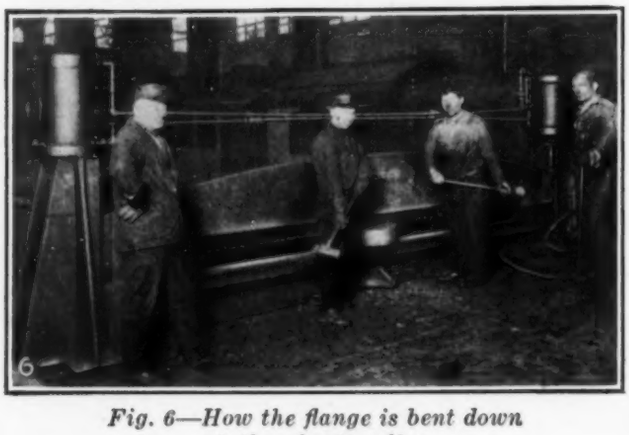


Fig. 6—How the flange is bent down at the short radius

flange around the contour of a flue or back-end sheet by which the latter is joined to the wrapper sheet of boiler or firebox, as the case may be. The machine is portable and may be placed by the crane wherever its services are needed. Connection is made by flexible hose to the air mains of the shop at any convenient point to supply power.

Although a large part of the flanging is done while the sheet is practically cold, it is necessary to anneal it in order to avoid straining the metal when making the comparatively short bend. The sheet is heated in a large oil-fired furnace and drawn out upon the hearth to cool. When the temperature is reduced to a point where the sheet can be handled with gloves, it is suspended from a jib crane and brought to the machine.

The machine is first adjusted to make a bend to approximately a 45-deg. angle and the edge of the sheet is turned down to this angle all the way around. The machine is then reset to make a right-angle bend, and the edge is turned down approximately square all the way around, except at the rounded corners where the short radius would cause serious buckling and straining of the metal if the work were done on the cold sheet. The remaining part of the job is a forging operation.

In Fig. 6 is shown how the sheet is handled for the latter part of the operation. A round block of cast steel, having the same radius as the corner of the sheet to be flanged, is placed upon the apron of the large air-operated clamp. The sheet, which has been made red-hot at the corner, is laid over and clamped down tightly upon the block by admitting air to the cylinders of the machine. The flange, already bent half-way by the flanging machine, is then driven down against the block with sledges, using the block as an anvil.

The operation for which preparations are being made in Fig. 7, is the flanging around the door-opening of a door sheet, and it is done in very much the same way as the operation just described. A large rectangular block is set up, partly upon convenient blocking and partly upon the apron of the clamp. A hole in the block corresponds in every respect to the hole in the door sheet as it is to be when the flanging has been completed, even to the radius of the corner over which the flange is to be bent. The metal around the door opening—the latter having already been cut in the sheet

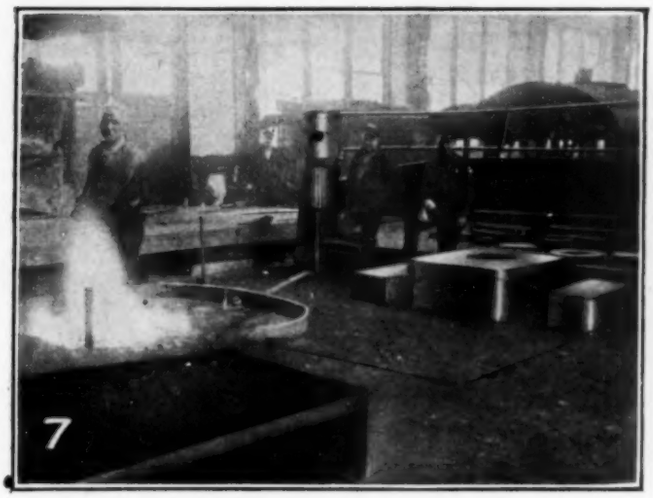


Fig. 7—Heating a sheet to flange fire door.

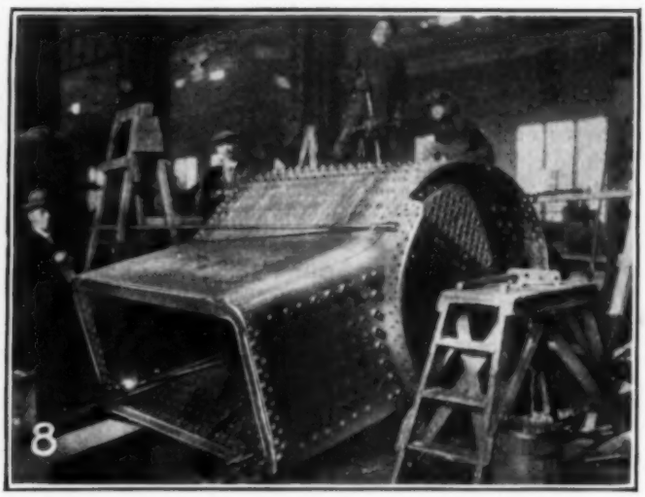


Fig. 8—Putting a new firebox in a boiler

by means of an oxyacetylene torch—is brought up to forging heat on an open fire, the sheet laid in position upon, and clamped to, the block, and the flanges turned down with sledges and flatters.

Though the number of engines to require complete new boilers is not large, the contingency may be expected at any time and the boiler shop must be always prepared to meet it. On the other hand, new, or partly new, fireboxes are a common requirement and more likely than not to be included in the repair order. In Fig. 8 the workmen may be seen putting a new firebox into a partly assembled boiler.

The flue washing machine, or rumbler, shown in Fig. 9, saves an infinite amount of time and labor in cleaning flues and tubes that have been taken out of a locomotive boiler after a term of service and are to be safe ended. As the flues are removed from the boiler they are stacked in cradles built on special cars, the cars wheeled under the machine, as may be seen in this illustration, and the chains of the machine adjusted to lift the bundle of flues. The car is then withdrawn and the bundle of flues lowered into a potash tank below the floor level.

The chains—there is one at each end of the machine—run over driving sprockets keyed to shafts extending the length of the machine above the frame. The bundle of flues rests in the bights of the two chains in such manner that when power is applied to the driving shaft the bundle will be rolled about as if it were an idler wheel.

The friction of the flues against each other as the bundle is rolled about, the jarring, and the action of the hot potash solution circulating through and about them, soon loosens and washes out any scale and sediment that may be in and upon them.

To convert the machine into a hoist by which the bundle of flues may be lifted out of the tank and high enough above the floor to allow the waiting car to be run under it, and then to deposit the flues in the cradle of the car, it is necessary only to stop one of the overhead shafts from rotation and continue to apply power to the other. Clutches, brakes and a reversing motor are the means by which the machine is enabled to perform its dual function.

Tubes and flues deteriorate much more rapidly at the ends where they pass through the flue sheets than elsewhere throughout their length, therefore when a set has served its term of usefulness in a locomotive boiler and must needs be discarded because of the condition of the ends, the greater part of each is still in good condition for further service. Merely to cut off the ends would leave them too short to go back in a boiler, and so they are safe ended and made serviceable by welding short pieces of new tube on the ends to make up the required length.

A system of hammer welding has been developed here by which the work is handled very efficiently. The machinery, which may be seen in Fig. 10, consists of an oil-fired furnace and two air-operated hammers, one of which stands behind and in line with the furnace, and is fitted with a pair of swaging dies, the opening in which corresponds to the size of tube or flue to be welded. The other hammer, which stands beside the furnace, is fitted with similar dies except

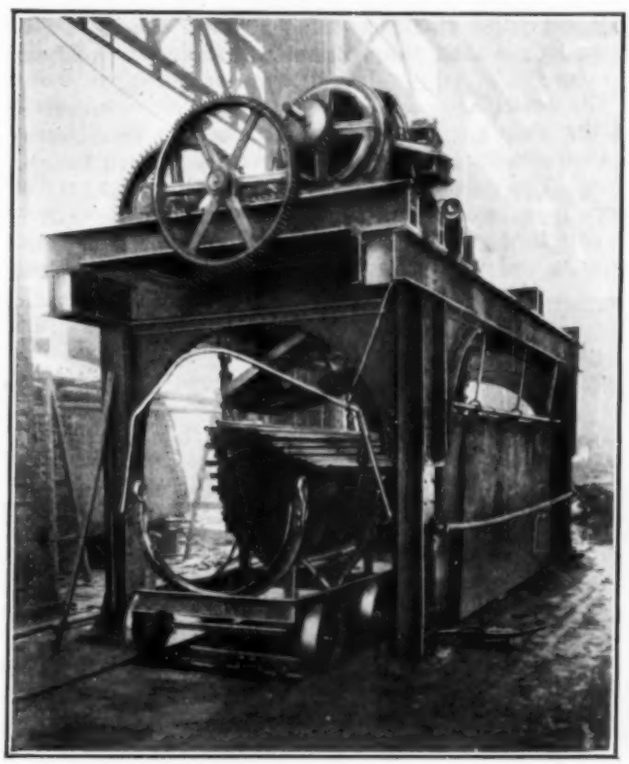


Fig. 9—Machine for washing flues and tubes

that the opening formed by their active faces, when together, is tapered and of a size to close in the end of the tube slightly. This operation is called "pointing," or "scarfing."

The operation is divided into two parts. The ends of a set of flues are prepared for welding by heating them to a forging heat and pointing them in the dies of the air hammer, and an equal number of safe ends are flared by driving them while hot on the tapered horn of an anvil. The second part of the operation is done by the hammer behind the furnace, and the weld is entirely out of the operator's sight.

In Fig. 10, *A* is a bar-anvil, supported by brackets *BB* that are adjustable along the member *C* to accommodate different lengths to be welded. The bar-anvil passes through the opening formed by the closed dies of the air-hammer *D* and extends into the furnace, but does not reach the flame of the oil jets. With a pair of tongs, the operator or his helper passes a safe end through the furnace and slips it over the end of the bar-anvil, pushing it along until the flared end—the end nearest himself—is in the hottest part of the fire. He then follows it up with one of the long flues, which lies in suitable rests before the furnace, and leaves the scarfed end of the flue also in the fire, close to the safe end.

Within a few seconds the adjacent ends of the flue and the safe end have reached a welding heat, when the operator pushes the flue along, shoving the safe end ahead of it until the opposite end of the latter abuts against the first bracket *B*, which also acts as a gage to bring the heated end of the safe end into the dies of the hammer.

A blow on the outer end of the flue drives the scarfed end into the flared end of the safe end, and the pressure of the operator's foot upon a pedal sets the air hammer in motion. During the few seconds that the hammer is in action, the operator rotates the flue slowly, and, almost before what is taking place can be observed, a single continuous flue a couple of feet or so longer than the original is withdrawn from the furnace.

The device shown in Fig. 11 is one that was evolved in the shop for the purpose of cleaning and testing the superheater units, carried by most modern locomotives. The unit (there may be from thirty to fifty or more in a locomotive) consists of a long pipe that is twice folded upon itself, so that from the bend *A* to the opposite end (which cannot be seen in the illustration)

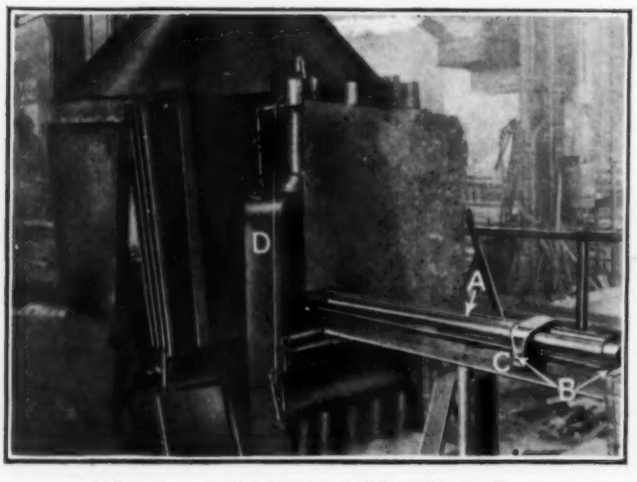


Fig. 10—A device to weld ends on flues

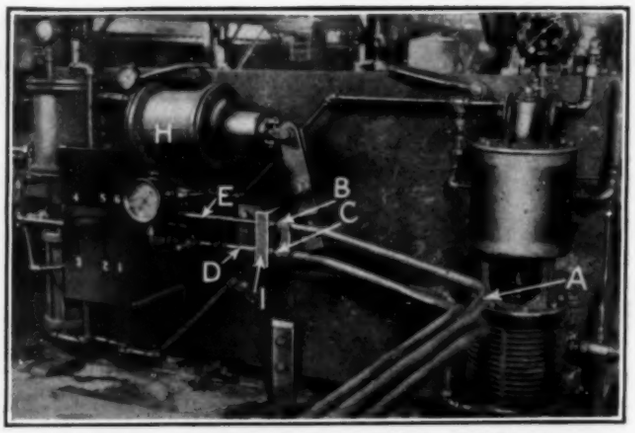


Fig. 11—Washing superheater units

there are four parallel members. From the union *B* to union *C* the unit is a single unbroken conduit without joint or seam of any kind.

Because of the large number of units to be handled and the impossibility of getting a wire or tool into the interior, the job of cleaning them assumes considerable proportions.

The device here shown is self-contained, being supplied with air by a Westinghouse air-brake pump and with water at high pressure by a duplex hydraulic-pump, both air driven and both mounted behind the panel. Water for flushing the units is supplied from the shop service mains. The operating panel is at the left, where the numbered stations may be seen. Pipes *D* and *E* are inlet and outlet, respectively, and lead to the control valves of the machine.

A helper places a unit in position as here shown and the operator depresses the first lever to position No. 1, which admits air to the cylinder *H* and, through its piston-rod and lever connections, clamps the unit to the header *I* of the machine. At the same time the outlet is opened and air at 90-lb. pressure is admitted to the unit, blowing out all loose dirt and sediment that may be inside.

Allowing the air to blow through for an instant, the operator then depresses the second lever to position No. 2, which cuts off the air and allows water from the service mains at 50-lb. pressure to flow through the unit and wash out any dirt that the air blast did not remove. Depressing the third lever to position No. 3 cuts off the water from the mains and connects the units to the delivery end of the high-pressure pump, setting up a hydrostatic pressure of 550 lb. per sq.in. to test it for possible leakage.

The high pressure is allowed to remain on long enough for the operator and helper to locate any leak that may exist, after which the third lever is returned to position No. 4, cutting off the high pressure and opening the outlet. Raising the second lever to position No. 5, again admits air at 90 lb. to blow out the water, and raising the first lever to position No. 6 releases the clamps that hold the unit to the machine. The entire operation time from floor to floor is less than one minute per unit.

It is well to remember that the best planning in the world cannot accomplish results without intelligence and loyalty in carrying out the plans. Unless we secure the co-operation of the men in the ranks, we cannot attain real success.

The Measurement of Cutting Temperatures

By E. G. Herbert
Director, Edward G. Herbert, Ltd.
Manchester, England

Instantaneous temperatures generated by sawing, tapping, chip shearing, chattering tools, and hardness tests—Effect of high intermittent temperatures on tools

IN FIG. 15 is shown an example of voltage generated by a tool-steel, mild-steel couple. The cutting tool was in this case a "Rapidor" hacksaw blade containing 18 per cent tungsten, and the work was a bar of mild steel 1 in. in diameter. Cutting was done dry at 156 strokes per minute in a "Rapidor" machine, and the chips came off red hot. In cutting stainless steel under identical conditions the blade became red hot, but there was not sufficient material for calibration.

The thermograph gives clear evidence of a parabolic voltage curve. The cutting stroke commences at *a*. The peak voltage is passed at *b* with rising temperature.

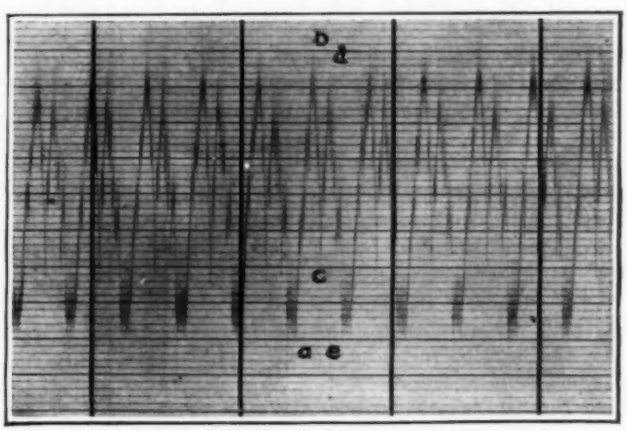


Fig. 15—Sawing mild steel with a high-speed steel blade
(10 mm. = 1 mv. 1 second time marks, speed 156 strokes per minute)

The maximum temperature at *c* coincides with the end of the cutting stroke. The temperature falls from the beginning of the back stroke, passing again through the peak at *d* and attaining normal value at *e* when the blade was lifted clear of the work. The diagram is part of an investigation into the hot hardness of saw blades, which does not fall within the scope of the present report.

The graph of Fig. 16 gives the thermal history of tapping a ¾-in. hole in aluminum bronze by hand. Starting from the left the rise of temperature due to every movement of the tap can be clearly seen, the temperature falling after each movement but showing a general rise as the tool and the work became warm. At *a* the tapping process was completed and a pause of 7½ sec. was made during which the temperature fell somewhat. The tap was then backed out and finally removed from the hole, where the sudden drop of voltage occurs. The tap-bronze couple was calibrated and the maximum temperature found to be 120 deg. C.

In Fig. 17 is shown a similar diagram of tapping a ½-in. hole in mild steel with an ordinary steel tap. It calls for no special comment except that at *a* the tap became fast in the hole and had to be reversed to release it. The last few turns at *b* were made quickly, as the parallel part of the tap had been reached. At *c* there was a pause of 11 seconds, after which the tap was rapidly backed out of the hole.

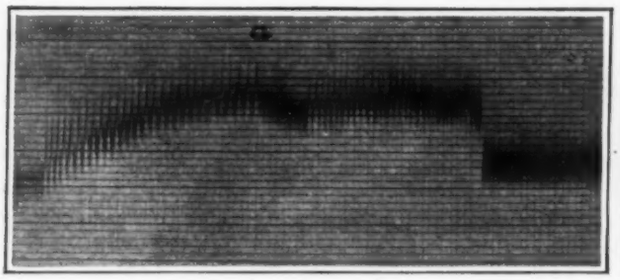
The temperature generated by hand tapping may not be important. Probably it does not often occur that taps are softened by over-heating when used by hand. But the fact that a temperature of 120 deg. C. was generated when tapping a ¾-in. hole by hand has a bearing on the subject of hot hardness in screwing dies, which are often required to take quite heavy cuts in the bar lathe and screwing machine.

The tapping diagrams illustrate the manner in which the new method of investigation may be used to record the inner history of a series of complicated movements, whether performed by hand or in the machine tool, showing the temperatures to which the tool and work are subjected at every stage, and yielding information as to tool efficiency, the resistance of metals to working and doubtless many other subjects of interest to the engineer and the metallurgist.

The fluctuations of temperature which accompany the familiar shearing of the chip into partially detached segments are shown in Fig. 18. The tool was of high-speed steel and the bar of mild steel. The depth of cut was ¼ in., the feed $\frac{1}{15}$ in. and the speed 7.66 ft. per minute. Each time a partial shear took place there was a drop in temperature due to the reduction in pressure on the tool.

In Figs. 19 and 20 examples of temperature generated by chattering tools are given. In Fig. 19 a cast-iron pulley was being turned. The fluctuations in the voltage curve correspond to vibrations of the tool at the rate of about 80 per second. A loud note of high pitch was emitted by the pulley, the vibrations being several octaves above those of the tool. In Fig. 20 a steel tool was turning a mild steel bar.

The conclusion of the paper presented at the Annual General Meeting of the Institution of Mechanical Engineers, London, England, Feb. 19, 1926. The first part appeared on page 281.



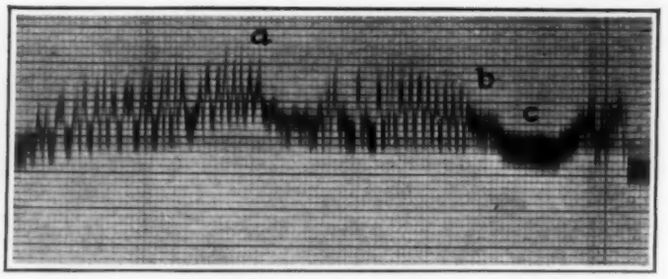


Fig. 16—Tapping a ¼-in. hole in bronze by hand (20 mm. = 1 mv. 1 second time marks). *Fig. 17—Tapping a ½-in. hole in mild steel* (20 mm. = 1 mv. 1 second time marks)

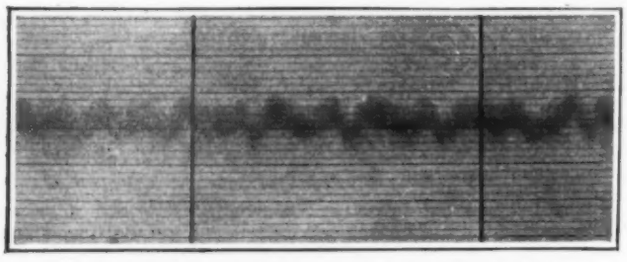


Fig. 18—Segmental shearing of the chip in turning steel

Illustrated in Figs. 21 and 22 is a method of investigating machinability whose possibilities are believed to be great. A bar or disk of steel, or other metal under investigation, is chucked in the lathe and the end is turned quite flat. A surfacing cut is then made, either from the center to the periphery or vice versa, while a thermographic record is made of the voltage. Thus there is a perfectly uniform increase or decrease of cutting speed between zero at the center and any desired speed at the periphery of the specimen, and a record of the corresponding increase or decrease of temperature. If the metal is uniform, and if its machinability is unaffected by any of the temperatures generated in cutting, the resulting graph should be a smooth curve. On the other hand, any increase or decrease in the resistance offered by the metal to the cutting tool at any given temperature should be revealed by a peak or a depression in the voltage curve.

The curve shown in Fig. 21 is the thermograph of a surfacing cut commencing at the periphery of a 2¼-in. mild steel bar, and finishing near its center, while that shown in Fig. 22 is from a similar cut starting at the center of a 4-in. bar and finishing at its periphery. In many of these curves there are fluctuations which are attributed to changes in the machinability of the steel at particular cutting temperatures, but the investigation has not yet gone far enough to enable a definite correlation to be made between these fluctuations and the changes which are known to take place in the vertical force on the tool at certain speeds, or with the physical changes, particularly in work-hardening capacity and ductility, known to occur in mild steel and other metals when they are heated to certain temperatures.

Investigation has been made into the temperatures generated by three hardness tests, the pendulum hardness test, the Shore Scleroscope, and the Brinell test.

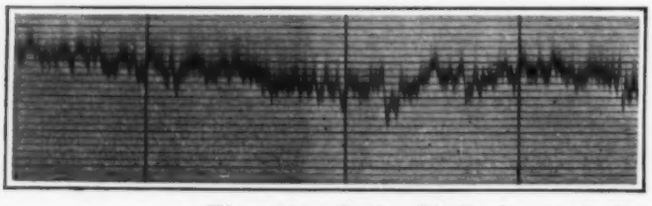
In the case of the pendulum no sensible rise of temperature occurred as a result of either the time, scale, or work-hardening tests. Any sliding of the ball over the surface of the specimen produced a marked deflection of the string galvanometer, but the deflection resulting from the slow rolling motion characteristic of these tests was barely perceptible.

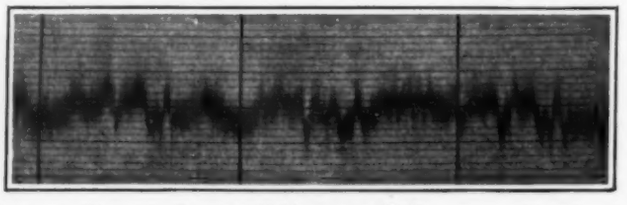
A negative result was obtained also with the Scleroscope, using a hammer of high-speed steel and specimens of soft steel and other metals. There is reason to believe that in this case a considerable rise of temperature does occur. When the hammer was placed in contact with the specimen and lightly tapped so as to produce impressions similar to those caused by the regular test, there was a decided voltage kick, but none could be detected when similar impressions were made by the falling hammer. Does the rise of temperature take place after the blow, and after the circuit has been broken by the rebound of the hammer?

In the case of the Brinell test, using a 10-mm. steel ball and a 3,000-kg. load, the temperature rise was inconsiderable when the load was applied in 5 sec., but when applied in 2 sec. or less there was a considerable rise of temperature. In the thermograph, Fig. 23, the first hump was caused by the application of the main part of the load in about 1 sec. and the second hump by the final adjustment of the load. In Fig. 24 the load was applied in about 1½ sec. The tests were made in the Olsen universal testing machine, and the maximum temperature rise recorded was 32 deg. C.

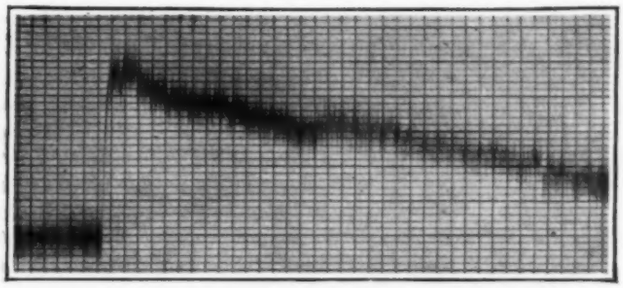
Effect of High Intermittent Temperatures on Tool Steel

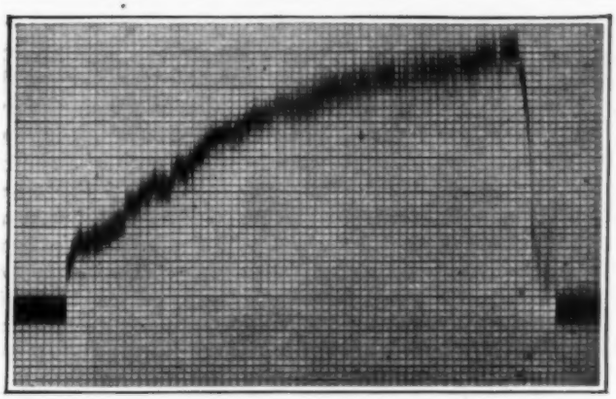
The experiments have shown that the temperatures generated by many ordinary cutting operations, especially those of a percussive or intermittent character, are surprisingly high, so high indeed that any tool which was subjected to such temperatures continuously, or for even a moderate period of time, would inevitably be softened. The fact that tools are able to withstand such temperatures and retain their hardness suggests interesting questions as to the influence of the time fac-





Figs. 19 and 20—Chattering tools (10 mm. = 1 mv. ½ second time marks)





Figs. 21 and 22—Surfacing mild steel
(10 mm. = 1 mv. 1 second time marks)

tor and the influence of repetition on the softening of tool steel by very high temperatures intermittently applied.

No complete answer can yet be given to these questions, but it is possible to state some facts bearing upon them.

In Fig. 15 it was seen that the voltage curves of a high-speed steel saw blade cutting a mild-steel bar are of parabolic form both in heating and cooling. A couple made of this identical blade and bar was calibrated by heating it in an electric furnace from 20 deg. to 1,125 deg. C. and measuring the voltage at successive temperatures. The resulting voltage curve was not parabolic. The voltage rose continuously with the temperature but showed partial arrests at 600 deg. and 900 deg. C.

A further calibration was made with portions of the same blade and bar, the couple being immersed at intervals in a lead bath which was gradually heated in the furnace. The couple was allowed to remain in the bath only long enough to obtain a steady reading at each temperature and was then quickly withdrawn. The voltage curve (Fig. 25) showed an arrest at 730 deg. C. but continued to rise at higher temperatures, the parabolic form again being absent. Thus the voltage curve obtained in calibration was totally different in form to that obtained in cutting.

To explain these facts the following hypothesis was adopted. The thermo-electric properties of a couple made of tool steel and mild steel depend on the difference in chemical composition of the two steels. If, as a result of heating, the chemical composition of either element is changed, a corresponding change may take place in the thermo-electric properties of the couple. But the chemical changes which take place in steel as a result of heating require time for their accomplishment. It is therefore possible that changes which take place completely when the steel is slowly heated in the furnace may take place less completely, or only at higher temperatures, when the steel is immersed in a lead bath and withdrawn after a few seconds, and that these changes may not take place at all when the heating and cooling occupy only a fraction of a second as in the operation of sawing. It was assumed that a chemical change, probably associated with the softening of the tool steel, took place at *x*, Fig. 25, and that if this change had not taken place the voltage curve would have followed a parabolic course as indicated by the dotted line.

To test this theory a thin couple was made of a portion of the same blade and bar, and this was plunged into a lead bath at 900 deg. C. while a thermographic record was made of the voltage.

The resulting record is reproduced in Fig. 26. The couple entered the lead bath at *a*. The voltage quickly rose to a maximum at *b*, and tracing a parabola fell to *c*. At this point the softening change is believed to

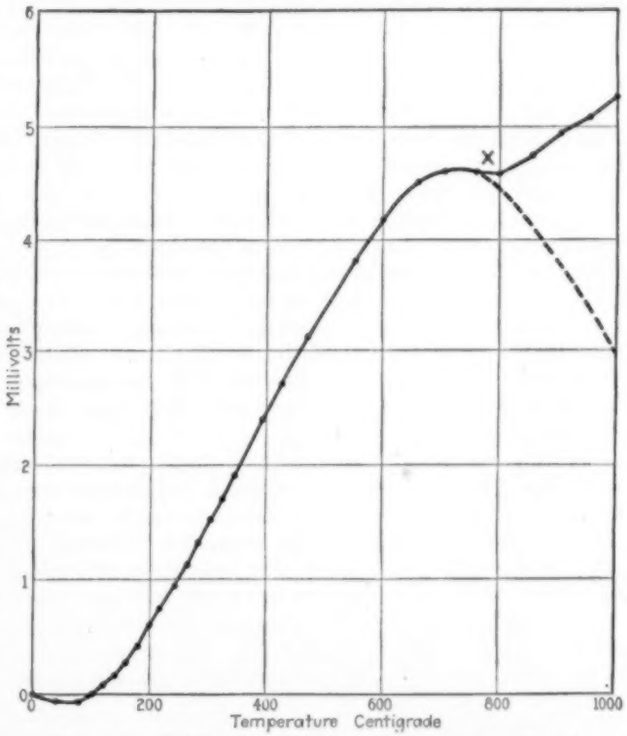
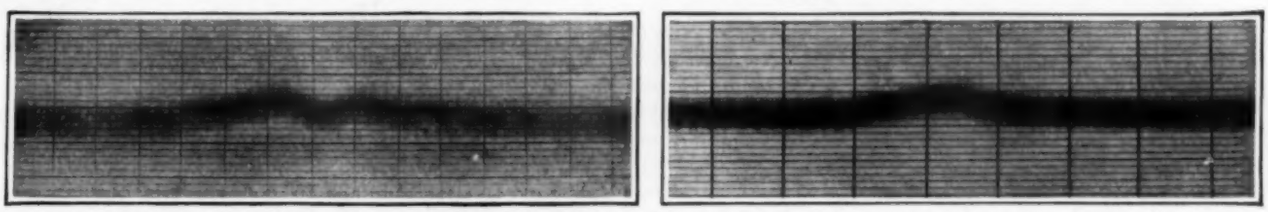
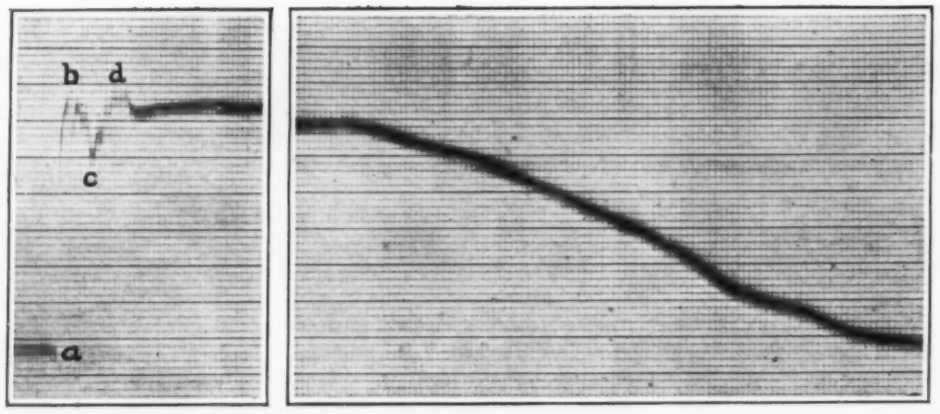


Fig. 25—Calibration curve of thermocouple of high-speed steel saw blade and mild steel bar



Figs. 23 and 24—Rise of temperature due to Brinell test (10 mm.-ball 3,000-kg. load, 20 mm. = 1 mv. ½ second time marks in Fig. 23, 1 second in Fig. 24)



Figs. 26 and 27—Heating and cooling voltage curves of high-speed steel, mild-steel thermocouple (1 second time marks, 10 mm. = 1 mv.)

have taken place. The voltage rose again to *d* and eventually became steady. When the couple was removed from the bath and allowed to cool, Fig. 27, the voltage fell continuously without fluctuations.

It will be seen that the assumed softening change at *c*, Fig. 26, occurred 8 sec. after the couple entered the bath, and 5 seconds after the attainment of the peak voltage at *b*, which probably corresponds to the temperature 730 deg. C. at which the arrest took place in Fig. 25. The peak voltage *b* in the sawing curve, Fig. 15, probably corresponds to the same temperature 730 deg. C. But the heating and cooling in this case only occupied one-third of a second, which is much less than the time required for softening the steel. The saw blade was as a matter of fact quite hard after the cutting was completed, whereas the tool-steel element of the calibrated couple was in every case found to have been softened by the calibration.

It may be inferred that caution is required in the interpretation of voltage curves obtained by cutting with steel tools, especially if the temperatures rise high enough to affect the steel during calibration. It has not yet been possible to produce a complete parabolic calibration curve corresponding to the curves obtained in sawing, Fig. 15. It is evident that the maximum temperature attained in sawing was very high—probably over 1,000 deg. C.

On the other hand the method illustrated whereby very thin thermocouples are plunged into molten metal at high temperatures and a thermographic record is taken of the resulting voltage, promises to throw further light on the subject of the resistance of tools to extremely high temperatures intermittently applied.

The apparatus used to measure the instantaneous temperatures is shown in Fig. 28. The source of light is the arc lamp *A*, the beam from which passes through the water bath *B* to the string galvanometer *C*, consisting of a powerful electromagnet with a hole bored through both pole pieces to allow the beam of light to pass. The glass fiber, silver coated and 0.007 mm. in diameter is contained in the brass fiber case *D*, inserted between the magnet pole pieces. The fiber is stretched across a small mica window in this case and is magnified by a microscope objective mounted inside one of the magnet pole pieces. The tension of the fiber is regulated by screw *E* and its position in the field by screw *F*. The metallurgical microscope *G* does not perform any function in the recording of temperatures except to support the projection lens *H*. The beam of light after emerging from this lens passes through the plano-cylindrical lens *K* which concentrates it into a narrow horizontal beam, and traversing the bellows falls on the graduated screen *L* on the falling plate camera *O*. The dark slide containing the photographic plate is suspended inside the camera from a hook attached to the piston rod of the oil dashpot *N*. The magnified image of the fiber is focused and adjusted on the sliding screen *L* which can be drawn back to expose a semi-cylindrical lens about 4 in. long on the back of which are millimeter graduation lines. Behind this lens and immediately in front of the photographic plate is a narrow slit which is brightly illuminated except where the shadow of the fiber falls across it. An extension to the arm of the metronome *J* passes across and obscures the beam of light at intervals, thus causing unexopsed time lines to appear in the photograph.

A standard voltage of 2 millivolts is obtained from the dry cell *P* in conjunction with the resistance *S*, rheostat *R* and millivoltmeter *Q*. This standard voltage is applied to the fiber, whose tension is so adjusted that its image deflects one centimeter, or two centimeters per millivolt according to the character of the record to be made. The fiber having been calibrated, it is connected to the tool-work thermocouple, the slit is exposed by drawing back the sliding screen and the plate is released. The millimeter lines on the semi-cylindrical lens trace graduation lines on the falling plate, the metronome produces time lines, and the shadow of the fiber traces an unexposed line. Every movement of the fiber is recorded as an undulation in this line, the amplitude of the undulations serving to measure the voltage and the temperature at the point of contact between the tool and the work.

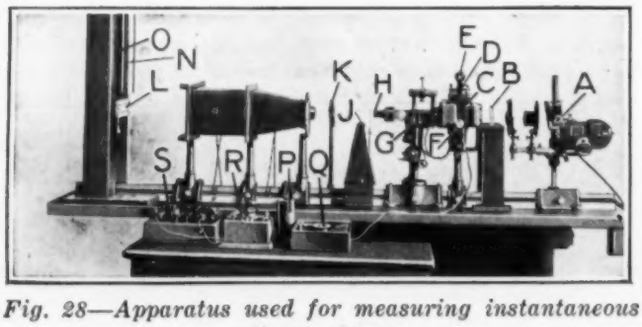


Fig. 28—Apparatus used for measuring instantaneous temperatures

Discussion

BY MAYO D. HERSEY
Bureau of Mines Experiment Station, Pittsburgh, Pa.

The thermoelectric, or tool-work thermocouple method of measuring cutting temperatures has evidently been developed independently on both sides of the Atlantic; this fact in itself tends to confirm the fundamental soundness of the method. The first published reference to this thermoelectric method is apparently to be found

in the first report of the special Research Committee on the Cutting and Forming of Metals, American Society of Mechanical Engineers, which was presented at the 1923 Annual Meeting in New York and afterward reprinted in *Mechanical Engineering*, Vol. 46, Jan., 1924, pp. 20-30 and 57. A later paper by Henry Shore gives the results of experiments in turning brass and mild steel with a tool of Jessop's steel (*Jour. Wash. Acad. Sci.* Vol. 15, March 4, 1925, pp. 85-88). The method was first suggested to the writer by Dr. Lyman J. Briggs of the U. S. Bureau of Standards, six years ago.

One question, which has never been fully settled, is that of the influence of pressure (or other stresses) on the thermal E.M.F. of the tool-work thermocouple. In Mr. Shore's experiments, this effect appeared to be negligible, yet it may have some bearing on the anomalies described by Mr. Herbert in the latter part of this paper. This matter has been further discussed in the first reference above cited (*Mech. Eng.* Vol. 46, page 23). The difficulty arises from the fact that the E.M.F. generated by a thermocouple is a function of the pressure as well as of the temperature.

Stellite Surfacing or "Stelliting"

By A. V. Harris
Haynes Stellite Co.

The process of "stelliting" consists of applying Stellite to parts called upon to withstand heat, abrasion, corrosion or a combination of the three. It can be carried out by means of the oxy-acetylene blow pipe or the electric carbon arc method. The oxy-acetylene process seems to be the more desirable and to give the more uniform results. Before the metal is applied to the base surface, the part must be perfectly clean so that good fusion is secured. The advantages of the surfacing are its resistance to abrasion and corrosion and its retention of hardness up to 1,800 deg. Fahrenheit.

The process was applied, in Canton, Ohio, to bending, forming and trimming dies. In the manufacture of railroad creepers a forming die made of alloy steel, costing about $50, ordinarily produced about six to ten thousand creepers before it was discarded. One of the worn out dies was given a new Stellite surfacing and ground to size at a cost of $10. It gave the run of 100,000 pieces before it again lost its size.

The process has been applied wherever crushing and pulverizing equipment is used. The life of screw conveyors has been increased six times by surfacing the flights when they began to wear. Good results have been obtained by surfacing the dies used in trimming forgings. These dies are subject both to heat and wear. In a cement plant the riding bars of chain conveyors carrying white-hot clinkers showed a wear of ☆ in. in 500 hours of service when the bars were surfaced, and about 2 in. when unsurfaced. Dies used in the manufacture of dry batteries showed increased resistance to corroding chemicals when they were Stellited. Valves and valve seats for use in homogenizing equipment, plungers and cylinder liners for chemical equipment, and other parts have been successfully surfaced.

The surfacing can be used in many other cases for different purposes. The metal is non-magnetic and was the means of making a certain type of electric hammer practical. The metal can be used in mirrors and reflectors where unbreakableness is required.

Abstract of a paper read before the Boston Section of the American Welding Society, Feb. 19, 1926.

Seen and Heard

By John R. Godfrey

Beware of "Bargains"

THERE is an old saying that "virtue is its own reward" and there are many who do not hesitate to point out that, all too frequently, self satisfaction is about the only reward it gets. Unfortunately it would be difficult to prove to the contrary.

So it is all the more gratifying to find cases where the other fellow does appreciate good service, and shows it. A while ago I ran across a case where a firm, with a reputation for buying very closely, gave a machine builder an order for a special machine without pinning him down to a definite price. And all because the aforesaid machine builder had refrained from profiteering during the war period. And just the other day another buyer of high-grade products told a manufacturer supplying him, that his product was so uniformly good that it was accepted without further inspection.

If people would consider the factor of reliability more carefully in placing orders there would be more encouragement for those who try to give value received to every customer. But the desire for a "bargain" seems to be strongly implanted in most of us, regardless of race or sex, and we are frequently tempted to place an order when we know it is impossible for it to be satisfactorily filled at the price named.

A case in point is that of a bid for a large, special milling cutter, by a small concern, at about half the price asked by the man who regularly supplied the buyer. Before placing the order the high bidder was called in to explain the reason for his high price. His answer was to ask the buyer to get his own shop superintendent to figure on the cost of this particular cutter.

Beginning with the cost of the steel, the super went over each item and, when he counted overhead, his cost price was much above that of the high bidder. The cost of the steel alone was nearly as much as the bid of the low priced competitor for the completed cutter. This difference made it evident that the low bidder either did not know how to figure, or that he counted on using a much lower grade of steel. Furthermore, the buyer woke up to the fact that unless the reliable maker got business enough at a profit to keep his factory running, he, the buyer, would be minus a source of supply that had always served him well in the past. So he passed up the apparent "bargain" and stuck to the reliable cutter maker.

When we are tempted by bargains it is always a good plan to bear in mind that every firm is in business to make money, and that unless it can do so, it must fail. We expect a fair profit on our own work and must be willing to let the other fellow make his profit also.

There is an old saying that if you make a good mousetrap you'll have a line of customers wearing out the front lawn trying to get to your door. But it doesn't seem to work out that way unless you have some way of letting mouse-ridden people know that you make this trap and where you live. Not only that, but you are likely to find that some one else has evolved, or copied your idea, and that your pet mousetrap is known by his name instead of yours.

Let the Draftsman See What Happens—Discussion

By W. Roland Needham
Goodmayes, England

A HIGHLY important subject was introduced by W. Edwards in his short contribution on page 586, Vol. 63, of the *American Machinist*. The present writer would add, certainly, and a very good idea too.

Many of the mistakes one makes and much of the imperfection which disfigures one's work, is just the inability to see things from the other fellow's standpoint. Draftsmen are naturally interested in their work from the essentially drawing office point of view. It's very easy to be satisfied with a production that is self consistent and free from contradictions. They have to (or ought to) be brought to realize that that is a partial and maybe a pernicious view. A drawing is not for drawing office consumption as the last resort. It has to be interpreted, and its constructions followed by men who are not draftsmen. Thus the drawing should make its definite appeal to the workmen who have to use it. If this be so, it is, to say the least, extremely advisable that draftsmen should familiarize themselves with the workshop mentality. It would do many an egotistical, complacent draftsman good to hear the machine shop, or pattern shop, or toolroom verdict on the drawings he produces, and which the workmen of these departments are called upon to interpret.

Misunderstandings Cause Much Friction and Waste

When a request comes from the shops for enlightenment, it is good that the man directly responsible should be entrusted with the job of explaining his work. By this means, in course of time, both workmen and draftsmen become educated to one another's ways, and each stands to profit thereby. It does the draftsman good and helps to perfect his art. He develops a technique that can be readily understood. Misunderstandings are prolific causes of friction and waste. They are cut down very considerably when a definite bid is made to meet the essential needs of the case, and when the drawing is made intelligible to those whose job it is to carry out its constructions.

It is one of the very best experience for a draftsman if when a workshop S.O.S. for explanation is given, perhaps of assembling routine or locating directions, if he is commissioned to straighten matters out. If he be in error, he will be brought to see his shortcomings as he could in no other way. When brought up against the practical implications of his work, he will learn to know the essential meaning and purpose of things. All this is of the utmost value to him, even if at times the experience is slightly mortifying to his pride. He is given opportunity to make good and to prove himself to be a bona fide engineer. Every draftsman, worth his salt, is an engineer.

First and foremost, however, he will have learned the difficult art of presenting his instructions in such a way, that those to whom they are given can intelligently execute their tasks. There is no question as to how the management will regard such procedure. Work will be done much more easily by the ordinary workmen; time will be saved directly by virtue of the increased rate of production; and indirectly by appreciable elimination of error; and the inter-relations of office and works will be amicable; possibly even cordial. All these things count tremendously.

The present writer agrees entirely with the original contribution and to what the latter urges would say, Yes, why not?

Catching the Mistake

By R. B. Willis

Quite a lot of printers' ink has been used lately for the purpose of helping the foreman along with his job. I suppose much of the material in such books or essays appears to the small shop foreman as somewhat out of his reach. For instance, the idea of scheduling or tabulating the foreman's job, and setting a limit to his responsibility would not seem practical to the small shop foreman. He has never found a limit to his responsibility, especially during times when things have gone wrong.

There is one idea he can use, however, even in the small shop. It is a good plan to tabulate the danger points of each job before the job is started. I think such points are called "high points" of supervision. Even small jobs sometimes have great danger points.

An example of such a job was illustrated in the *American Machinist* some time ago. The job was to put center holes in an eccentric arbor, holding the work in a milling machine vise, using an indicator to set the work central with the machine spindle, and then raising the knee the desired amount for the eccentric center hole location.

What lies in wait to spoil this job is backlash. Long experience has shown the necessity of always insisting that the zero setting be made with the full weight of the knee on the knee screw. That is, it must be possible to lower the knee and raise it again to read zero on the knee screw dial, and have the indicator still show the work central with the machine spindle.

It is a fussy operation to set the work central and unless the foreman insists on this method, even a good mechanic sometimes will forget and just ease the knee down a little to make the indicator read right all the way around. In such a case the knee does not start until the full weight is on the knee screw, and the arbor will not have enough throw. If the mechanic could imagine the work as moving along to the zero setting and again moving to the off-center setting, there would be less trouble caused by getting the backlash the wrong way.

One little kink is worth mentioning about eccentrics. Usually two or three thousandths' extra throw is permissible, and the hard work is nearly always done near the top of the throw, so that if the eccentric has this slight extra throw it will be nearer right after the first wear has taken place.

Not all danger points can be decided upon before starting a job. It happens often that a good man is carrying on a job and the foreman in passing by happens to think of some foolish mistake that could be made at about that stage of the job. Rather than seem to be a fuss-budget, the foreman says nothing. Right there is a danger point, because in about two cases in five that very mistake is made. Probably the psychologists could explain it, but the foreman of experience will stop and forestall the error even at the risk of appearing fussy.

Automotive Production

Willys-Knight Production Methods

By Fred H. Colvin
Editor, *American Machinist*

How two types of rods are machined in large numbers — Drilling and turning methods for hollow rods — Feeds and speeds used

THERE are two types of connecting rods used on the Knight engines. The 4-cylinder engines use the conventional, forged I-beam rods, while round, hollow connecting rods are used in the 6-cylinder engine, the latter type now being uncommon except in a few airplane engines. The hollow rods are very light and strong and their production involves a number of machining operations. Since many of the operations on both types of rods are similar, the production operations will not be kept separate for each type.

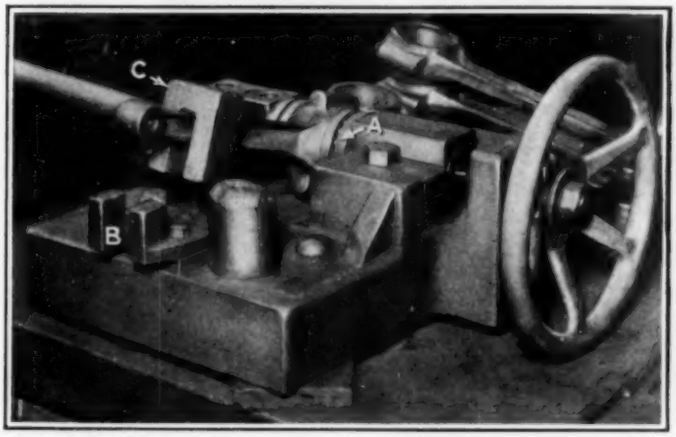
Connecting Rods

The forgings are inspected, and straightened in the device shown in Fig. 1. The large ends are clamped between the ball-bearing collars *A*, the jaw on the right being controlled by the large handwheel. The ball-bearing collars allow the rods to be moved, even when clamped firmly enough for straightening. The opening at *B* acts as a gage for showing whether the rods are straight and the two ends in proper alignment. The wrench *C* is of the usual type for straightening rods of this type.

Drilling and reaming the small ends of the rods is shown in Fig. 2. A feature of this operation is the way in which a 3-spindle machine has been fitted up to use cutting compound on the drilling operations and oil on the reamer. The reaming fixture is surrounded by the square pan at the left, so that the oil pumped on the reamer will be kept separate from the cutting compound. Each kind of coolant has its own pump and source of supply, and no difficulty is experienced in handling them both on one machine with the arrangement shown.

Locating surfaces are then milled on the bolt bosses as in Fig. 3, the method of location being somewhat unusual. The rods are centered by the small hole at the top and by suitable clamps at the bottom, the cutter flattening the sides of the bolt bosses. These flattened sides fit between locating blocks in the fixtures used for future operations.

The rods for the 6-cylinder engine have the bearing caps cut off on the Ohio machine as in Fig. 4, after the sides are flattened. This view shows just how the flattened sides are used to locate the rod between the blocks at *A*, and how the rods are held by the open washers that have slots in the sides through which the central cutter passes. The cutter spindle carries both the central slitting cutter and also a pair of cutters that face the ends of the bolt bosses. The outer



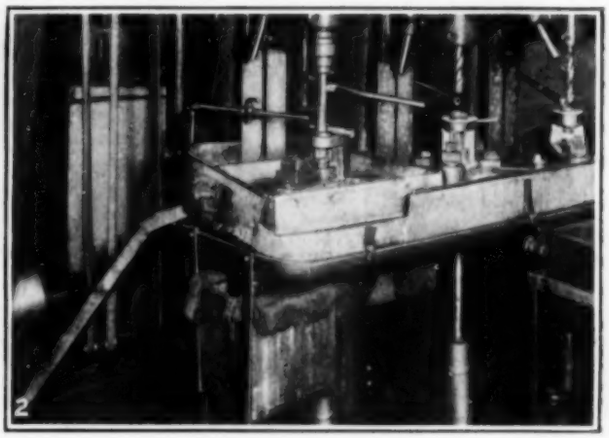
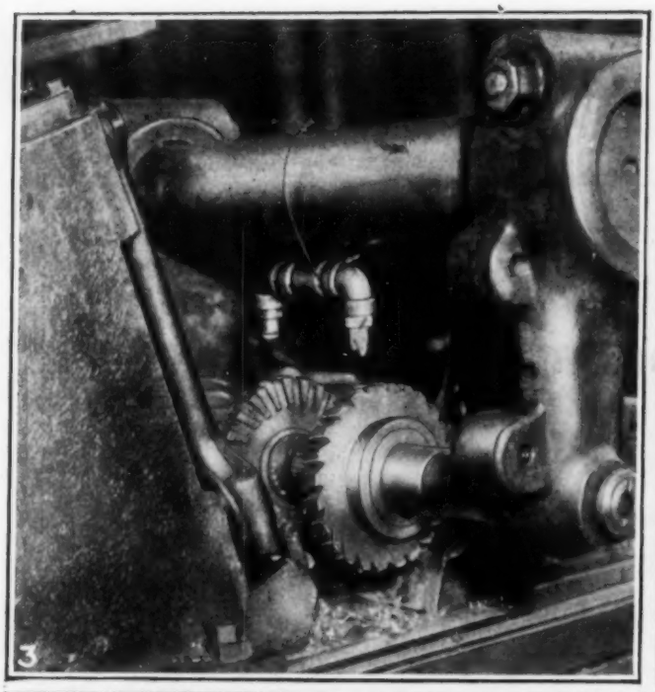
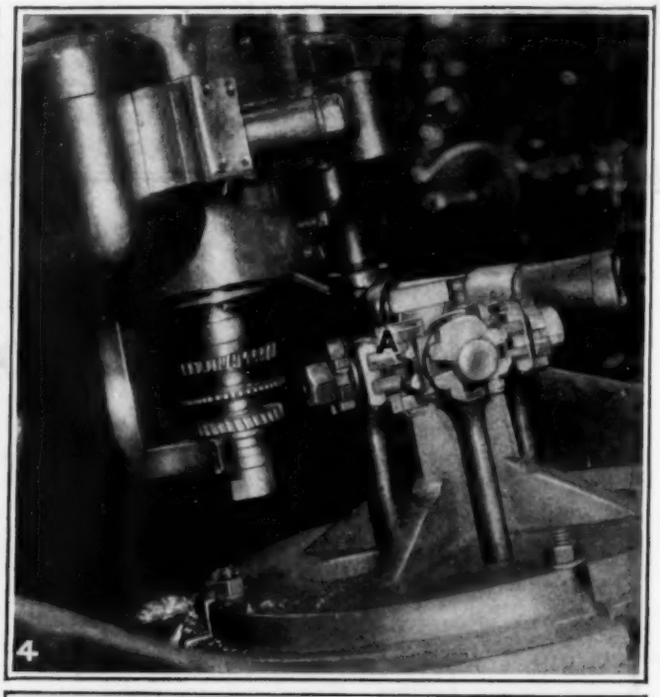
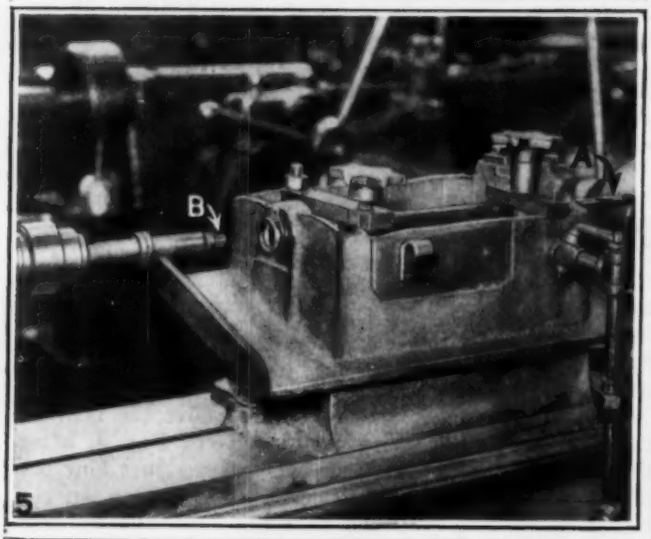
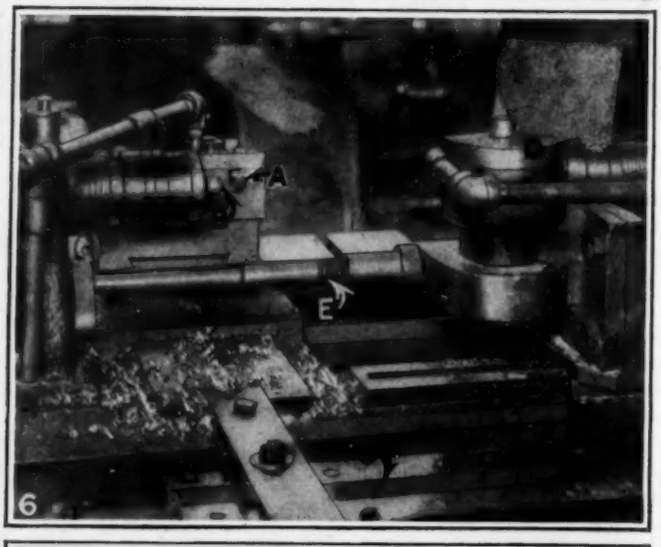


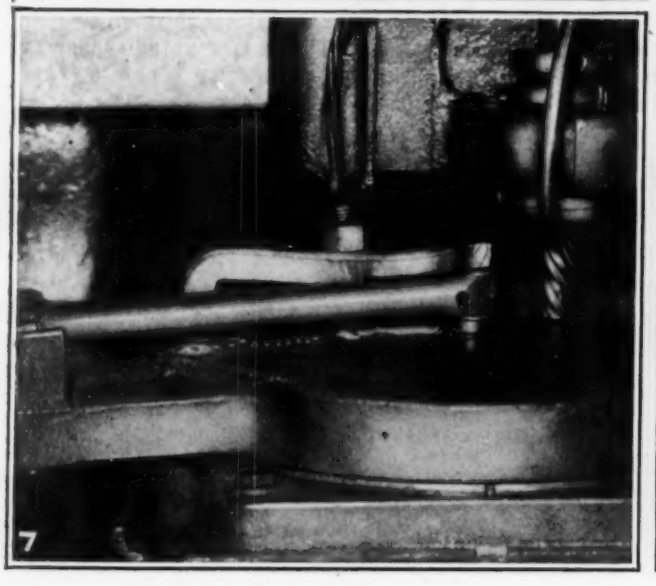
Fig. 1—Testing and straightening connecting rods. Fig. 2—Combined drilling and reaming of small end











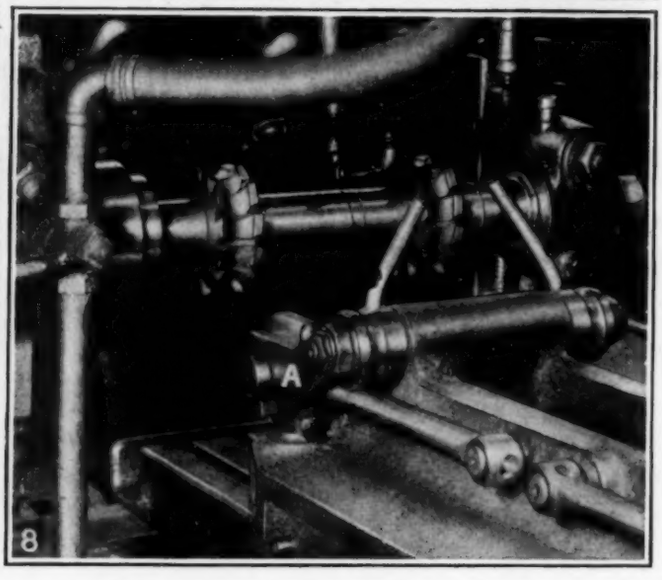


Fig. 3—Milling locating spots on bosses. Fig. 4—Cutting caps from rods. Fig. 5—Drilling the holes in rods Fig. 6—Turning the outside. Fig. 7—Profiling the small end. Fig. 8—Form milling the bosses

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end of the spindle is supported as shown. With the indexing fixture, the cutters mill one side of two rods, giving a complete rod at every cycle.

The rods are then ready to be drilled, the drilling being done from both ends in horizontal machines and in the fixture shown in Fig. 5. The two drills are of different lengths. The long one at *A* drills through the piston-pin ends of the rods. After the short drill has gone to its predetermined depth, it is withdrawn and a counterbore substituted as at *B*. In the meantime the long drill continues the hole until it breaks through. The counterbore cuts a recess in the lower end of the rod to receive a welch plug for preventing the oil from

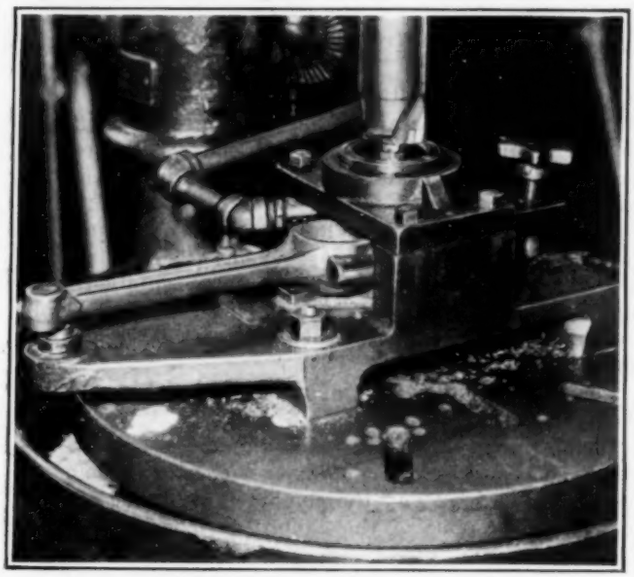

Fig. 9—Boring the large hole

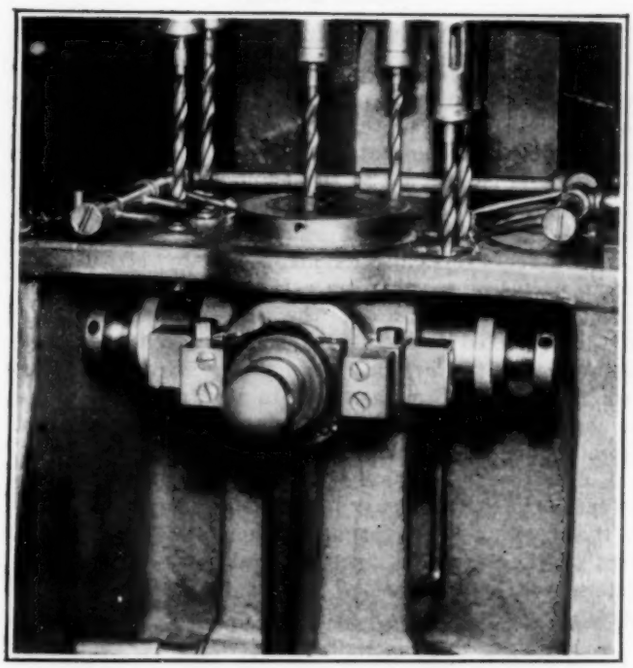

Fig. 10—Dividing the drilling operation

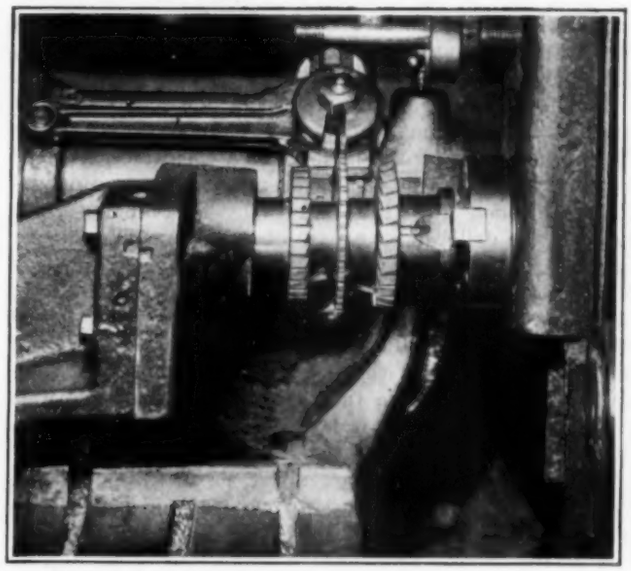

Fig. 11—Another cap-sawing method

the bearing getting up into the rod. There is an adjustable stop on the counterbore as shown.

The drills are ⅝ in. in diameter, and run at 300 r.p.m. with a feed of 0.008 in. per revolution. The fixture is built in box form and provision is made for flooding the drills with lubricant.

In turning the connecting rods after the drilling the lathe is fitted with special tools and fixtures as in Fig. 6, the rod being left out in order to show the turning tool *A*. The rod is driven by its large end and the drilled hole in the small end runs on the center *B*. The main part of the rod is turned by the tool *A* the movement of the toolblock being controlled by the cam slot at *C*.

The turning of the arc on the large end involves the use of a little mechanism that includes the tool turret *D* and the rack *E*. The turret is attached to the bed by means of the angle plate shown, and receives its motion from the rack *E*, on the rod that is fastened to the carriage and moves with it. As the carriage advances and turns the round portion of the rod, the turret begins to turn and carries its cutting tool on the proper arc to turn the large end of the rod, by the main bearing.

These rods are of S.A.E. 1040 steel and test to 172 Brinell hardness. They are turned at 400 r.p.m. and with a feed of 0.013 in. per revolution.

The finishing of the small end of the rod is done by milling with a vertical milling cutter and a rotary table as in Fig. 7. The rod is centered on a stud and clamped as shown.

In machining the bolt bosses, the fixture in Fig. 8 is used. It carries four rods at once, and is so designed that one pair can be unloaded and reloaded while the cutters are at work on the other pair. This operation is not performed until the caps have been bolted in place, as can be seen. The rods fit over a stud and the latch *A*, holds them against side motion, while a cam locks them firmly on the stud and prevents chattering.

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Going back to the channel or I-beam rod, the boring tool with inserted cutters is shown in Fig. 9. The rod seen in place is not in its proper sequence of operations, but shows the way in which it goes into the fixture.

The fixture for drilling the bolt holes is shown in Fig. 10, mounted on a Foote-Burt 6-spindle drill. The fixture holds four rods in a vertical position, and the locating blocks can be clearly seen. The drilling operation is divided into three stages by the varying positions of the drills in each pair of spindles. The fixture indexes to the left, and the first drills feed approximately one-third the depth of the hole. The next indexing position brings a new rod under the first pair of drills and while this rod is being drilled, the second pair of drills carries the holes deeper in the first rod, and at the next station the third pair of drills finishes the hole. In this way it is not necessary to raise the drills out of the work to clear the chips.

Then the rods are sawed apart so as to cut off the cap, as in Fig. 11, the work being done on a knee-type milling machine with the rods held in a fixture at the end of the table. This fixture holds four rods, and as in Fig. 4, one side of each of two rods is cut at the same pass of the table. The ends of the bolt bosses are also milled at the same time. It will be noted that the outer end of the milling-machine spindle is supported in a substantial bearing. This method is rather unusual for use on a knee-type machine.

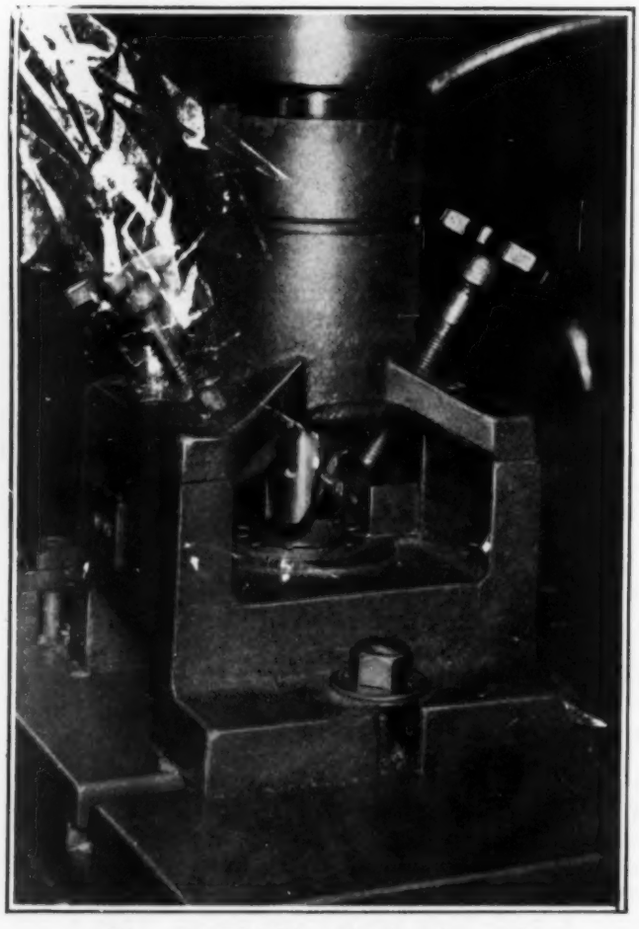


Fig. 13—Finishing the bearing ends

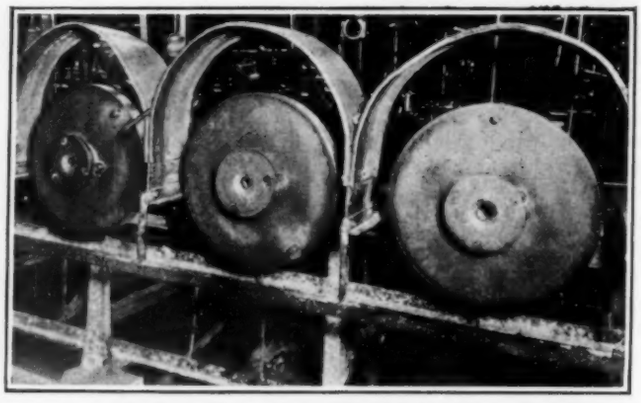


Fig. 12—Centrifugal babbitting stand

After the caps and the rods are assembled, the bores are tinned and they are babbitted by the centrifugal method as in Fig. 12. The small ends of the rod go on the pins near the outer edges of the disks, and the large bearings in the center. With the disks revolving, the babbitt is poured through the central holes by means of a ladle having a long spout. The ladle holds just enough metal for one rod and the rapidly revolving rod forces the metal against the wall of the bore and produces a very dense bearing, practically free from impurities.

For trimming the sides of the bearing after casting, the tool and fixture in Fig. 13 are used. The rod is located between the blocks inside the fixture by the flats on the bolt bosses. The angular side-screws hold the rod by the bosses, and the combined pilot and cutting tool trims the ends of the babbitt to length.

Crankpin Design for Electric Locomotives —Discussion

BY JOSEPH KAYE WOOD

Mr. James D. Burby's point that the factor should be inserted in the crushing stress formula in my article on page 62, Vol. 63 of the *American Machinist*, is correctly taken. As he states, the formula, for this type of stress, is correct up to the point where the vertical crushing force is reduced to terms of stress in lbs. per sq.in. The unintentional substitution of the word "radial" for "vertical," as mentioned by Mr. Burby, made previous to this operation probably accounts for the incorrect use of the surface area instead of the projected area. Radial stress, which is treated elsewhere in the article, has nothing to do with the crushing-stress formula. The tables from which the values of crushing stress were determined are calculated from the correct formula.

I, therefore, appreciate Mr. Burby calling the readers attention to the necessary omission of the constant $2/\pi$ in the crushing stress formula, although such a constant errs on the safe side since the tightness of pin fit is determined by the ratio S_c/S_r where S_r is the radial stress.

Well-defined shop aisles that are kept clear prevent accidents and increase production.

Automotive Production

Abstracts

from other publications

Ford Japanning

The selection of japanning equipment for the Ford Motor Co. of Canada, was the result of considerable study and numerous investigations, says Stanley Wishoski. The problem at this plant was to produce a limited number of bodies economically rather than any great quantity in a stated time. In the oven that was finally built the work, suspended from an endless chain conveyor, is carried up through one side of the oven around a partition separating its two parallel compartments and out the other side of the oven to the starting point.

The conveyor is of such a capacity that when once loaded with bodies, they are not removed until the three coats of japan have been applied and baked and the finished bodies have passed final inspection. The oven is heated by hot air from indirect gas fired heaters located beneath the oven. A single unit oven of the return bend type offers the advantage of economical use of floor space. It has a high thermal efficiency and is economical to operate. It can easily be installed in a room of moderate height and since it occupies one floor level, all parts of it can readily be inspected.

Although the conveyor carries 50 bodies when fully loaded, a 3-hp. motor furnishes the necessary driving power. The labor on each body is kept very low, only five men being necessary to operate the entire department. Including maintenance and supervision of the equipment the labor amounts to only 0.27 man-hours per body per coat.—*Fuels and Furnaces*, Jan., 1926, p. 59.

British Aeronautics

The British aeronautical industry, while not exactly prosperous, at least experienced no worse conditions than other branches of engineering. The output was confined in a large measure to military machines, neither commercial machines nor light airplanes of the class, produced in considerable number in 1924, figuring prominently in the returns. The chief feature of the year, however, was the greatly increased attention paid to metal construction, many planes being built of the metal type.

Judged by the number of passengers carried on the services between this country and the Continent, it would appear that civil aviation as a means of travel is making sure but distinctly slow progress. Operating costs are, however, still very high, and even the Director of Civil Aviation at the Air Ministry has had to admit that ten times the present traffic would be required before air transport could be made to pay its way. British air services of a regular character are still rendered possible only by generous assistance from the Government. The subsidized services operated with regularity and without major accidents. Plans are being negotiated for the institution of a regular fortnightly service between Egypt and India for passengers, mail and freight.

In 1919 the cost of air transport was estimated at $2.50 per ton-mile, today the cost works out slightly more than $1 per ton-mile at a speed of 95 m.p.h. With a passenger machine loaded to 60 per cent of its capacity, the cost per passenger with 40 lb. baggage is given as 16c. per mile. During the war and immediately afterward the best British machines could only fly about 250 hours before overhauling, today the cross-Channel airplanes fly for 1,500 to 2,000 miles without being overhauled.—*The Engineer* (England), Jan. 1, p. 10.

Ford's Methods in Ireland

A component which affords an admirable illustration of the Ford method of handling small parts in his plant at Cork, Ireland, is the piston. The first operation on this part consists of rough boring, facing, chamfering and turning the outside diameter of the skirt end at one setting. It is done on a Reed lathe equipped with a special form of expanding chuck, tool block and rotating center. Stellite cutters are used on this machine and an exceedingly heavy cut is taken. Following the boring operation, the skirt of the piston is reamed, removing approximately 0.016 in. of metal from the bore to a limit of 0.002 in. the operation being carried out on a 21-in. Cincinnati drill press. The gudgeon pin hole is next drilled and reamed in a special machine, this being a British B.S.A. ten-spindle drilling machine suitable for drilling six pistons simultaneously. The pistons are mounted on a central table capable of rotating about a vertical axis so that it may be located in any one of four positions.

The rough turning of the piston is done on a Foote-Burte machine. Stellite tools made from ¾-in. square stock are employed. The wristpin bushes are then pressed in position on an 8-in. stroke Ferracute press and the finishing of the grooves and the chamfer are done on a 14x4-in. Reed-Prentice lathe. Incidentally, soda water is used as a lubricant in these operations in connection with stellite tools.—*The Automobile Engineer* (England), December, 1925, p. 461.

Erratum. In reference to an abstract, entitled "British Manufacturing," published on page 436, Vol. 63, of the *American Machinist*, we received the following letter from the Armstrong Siddeley Motors, Ltd., Coventry, England:

"When rolling the cylinder bores, we do not use an abrasive as stated. The cylinder is reamed to between 0.0015 and 0.002 in. under size and the sizing roller is then passed through, oil being used as a lubricant. The rollers consolidate the face of the metal and leave a burnished close-grained finish."

Automotive engineers are finding new uses for rubber in car, bus and truck construction. Rubber is now being used as shock insulators at the ends of the springs; to cushion the mounting of engines in the frames; to lessen the fatigue stresses in the driving members; and to use between the seats and the floors or frames. This makes for longer life.

Book Reviews

Civil Aviation. A Report by the Joint Committee on Civil Aviation of the United States Department of Commerce and the American Engineering Council. One hundred and eighty nine pages, 6x9 in. Published by the McGraw-Hill Book Co., New York City. Price $2.50.

The volume is a general review of commercial aviation as it existed in 1925. Air transportation both in the United States and abroad is studied in detail and some very interesting facts are given. The number of routes and the miles flow in Europe are surprising unless one has kept pace with the subject.

The air mail is, of course, the outstanding feature in the United States and is probably the greatest achievement of any country in regular air transport. Its reliability and freedom from accidents are remarkable, considering the distance and the country over which it passes. The improvement in this respect is indicated by an increase in miles per forced landing from 6,140 in 1922 to 14,390 in 1925. The decrease in fatal accidents is even more marked. From 1918 to 1921 there was one fatality for each 138,600 miles flown, but from 1922 to 1925 there was but one fatal accident in 789,000 miles.

The fields for air travel were carefully studied and the results given are of great value. For photography, mapping, crop dusting and crop observation, the airplane offers great economies and there are many other fields.

The committee feels that, while subsidies are not necessary or desirable, the government should extend the same facilities, both for service and for safety, as it does marine transport. This means inspection and license of aircraft and pilots, the mapping and marking of airways for both day and night flying, weather maps, storm signals and similar aids. The book is well worth while for all interested.

Mechanical World Year Book, 1926. Five hundred and four pages, 4x6 in. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price 1s. 6d.

The 1926 edition of the Mechanical World Year Book is an encyclopedia on subjects of a mechanical nature. Each section is a condensed textbook on the subject with which it deals. A short discussion, formulas and tables are included in each division. The field covered has a wide range. Steam engines, turbines and boilers and their construction are first considered. Information on condensers and other equipment connected with steam engineering has been included to make the section a complete one. Seventy-nine pages are devoted to the subject.

Notes and formulas on gas, oil and Diesel engines have been prepared by W. A. Tookey. Problems relating to engine design and operation are solved as examples of the methods discussed. The necessary formulas and tables are well chosen and their uses explained.

Topics included under the general department on metals and structures are: the properties of metals and alloys, specifications for iron and steel work and tables on the strength of sections. The information on machine elements includes tables and formulas relating to shafting and gearing; discussion on strength factors, limit gages and fits, as well as notes on grinding, by W. H. Rhodes.

The titles of the following sections are: Notes on Cranes and Hoists; Hydraulic Work; Pipes and Tubes; Machine Foundations; Notes on Fan Work, by F. G. Whipp; Notes on Foundry Work; Screw Cutting and Threads.

Pages for memoranda and a diary are appended to the book.

Ouroboros, or The Mechanical Extension of Mankind. By Garet Garrett. One hundred and one pages, 4½x6 in., cloth boards. Published by E. P. Dutton & Co., 681 Fifth Ave., New York, N. Y. Price $1.

The only thing by way of preface to the book is an explanation of the title, an explanation desirable to be sure. However, the title is well chosen, because it truly expresses the contents, even though the appreciation doesn't arrive until the book is read.

"Ouroboros was a fabulous snake, the encircling serpent, that swallowed its own tail. It represented an infantile thought of the human mind for wish fulfilment by magical means. Man's heroic business was to conquer the reptile. As he did this he seized the object he most desired. He might even wish himself into solid gold." Such is the explanation.

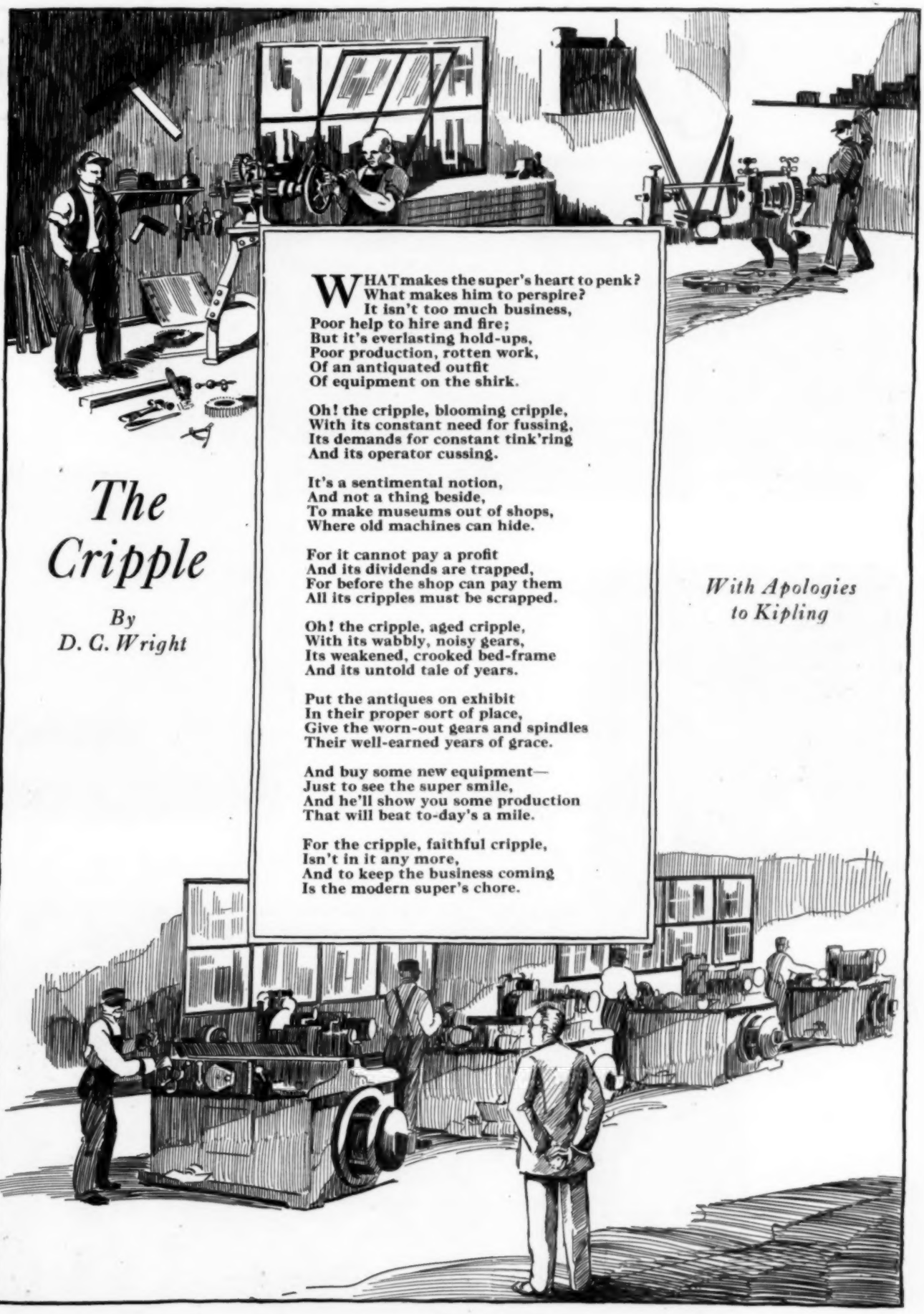
In about 15,000 words Mr. Garrett gives an economic treatise. He shows how machines came to be, what their effect has been and what it probably will be, as he sees it, upon domestic trade, foreign trade, nations, mankind in general.

The picture is none too bright, except as it is viewed with an abounding faith that effects differing from those we are likely to predict may result.

The book will start thought and had ought to be read. Beside helping toward conclusions concerning a rather distant probable happening, it will explain some of the present trends in foreign trade, and will add to our understanding of machines in the abstract and our respect for their power.

An Investigation of the Fatigue of Metals, Series of 1925. By H. M. Moore and T. M. Jasper. Bulletin No. 152, of the Engineering Experiment Station, University of Illinois. Ninety-four, 6x9 in. pages. Published by the University at Urbana, Ill. This bulletin is the fourth report of the progress of an investigation of the fatigue of metals, carried on at the university in co-operation with the National Research Council, the Engineering Foundation and several manufacturing firms. The previous reports are given in Bulletins Nos. 124. 136 and 142. No. 152 deals with the following subjects: fatigue strength and static strength of steel at elevated temperatures; the effect on fatigue strength of stress intensification at a small hole; magnetic analysis as a test for fatigue strength of steel; fatigue strength of non-ferrous metals; fatigue strength of case-carburized steel; testing machines for repeated stress; and miscellaneous test results for metals. The report is illustrated and contains many line drawings, graphs and tables that will prove useful.

It's a good plan to standardize on motors, both as to kind and sizes. Then you can keep a spare motor or two and avoid delays when anything goes wrong.



The Cripple

By
D. C. Wright

With Apologies to Kipling

WHAT makes the super's heart to penk?
What makes him to perspire?
It isn't too much business,
Poor help to hire and fire;
But it's everlasting hold-ups,
Poor production, rotten work,
Of an antiquated outfit
Of equipment on the shirk.

Oh! the cripple, blooming cripple,
With its constant need for fussing,
Its demands for constant tink'ring
And its operator cussing.

It's a sentimental notion,
And not a thing beside,
To make museums out of shops,
Where old machines can hide.

For it cannot pay a profit
And its dividends are trapped,
For before the shop can pay them
All its cripples must be scrapped.

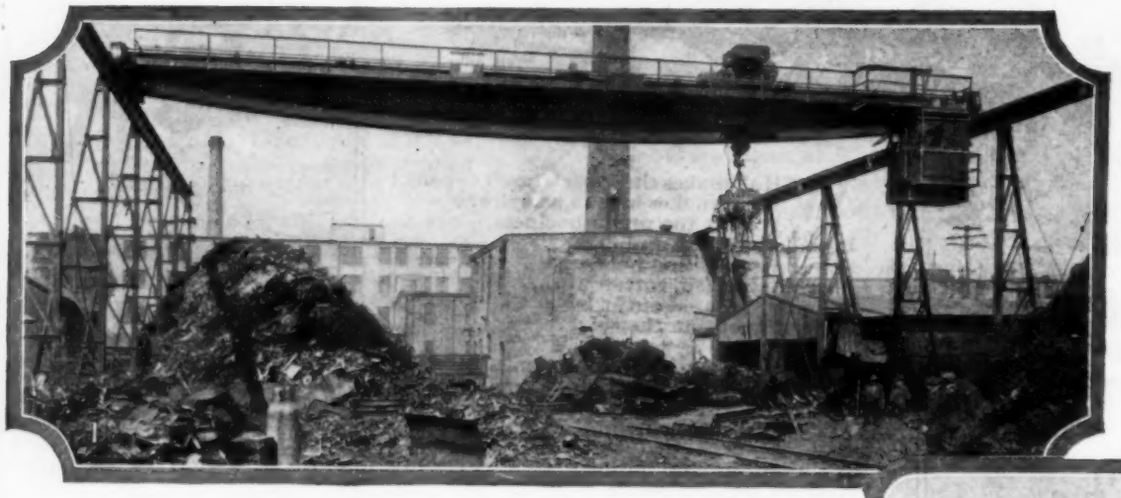
Oh! the cripple, aged cripple,
With its wabbly, noisy gears,
Its weakened, crooked bed-frame
And its untold tale of years.

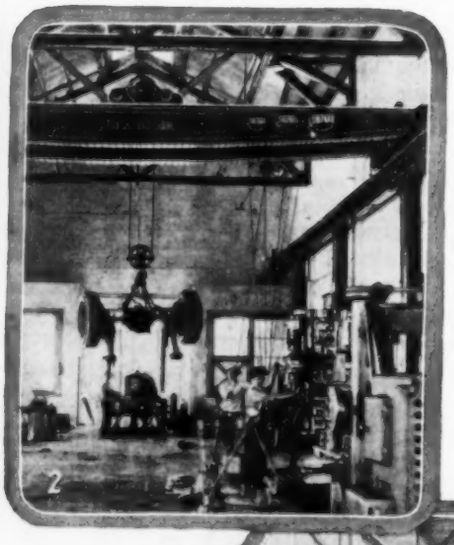
Put the antiques on exhibit
In their proper sort of place,
Give the worn-out gears and spindles
Their well-earned years of grace.

And buy some new equipment—
Just to see the super smile,
And he'll show you some production
That will beat to-day's a mile.

For the cripple, faithful cripple,
Isn't in it any more,
And to keep the business coming
Is the modern super's chore.

Modern Cranes in



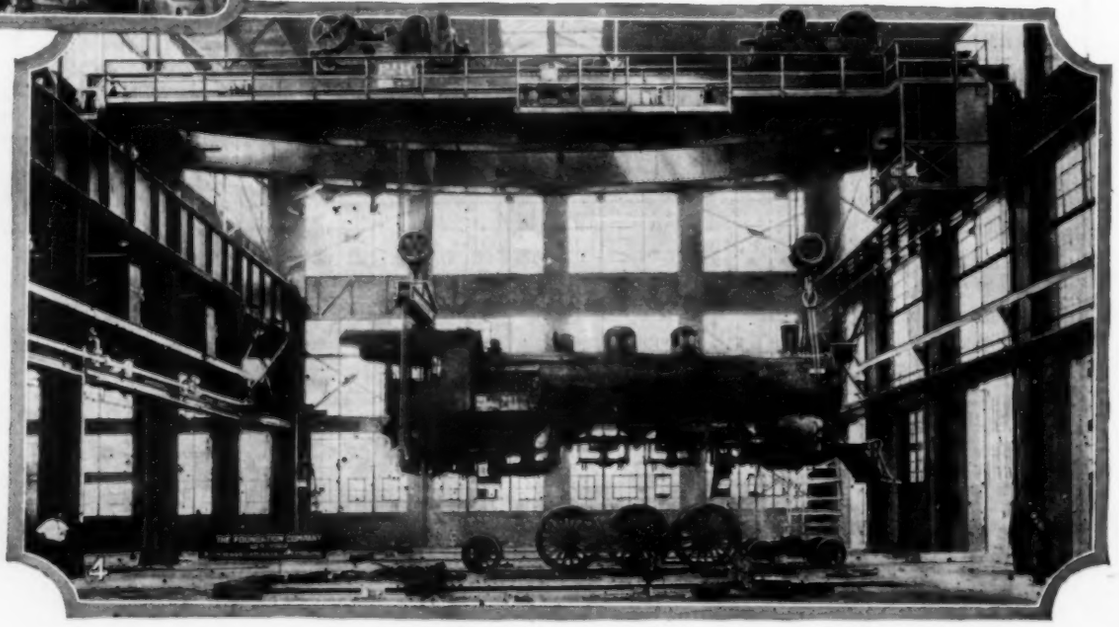


1—Cage-operated 5-ton crane—Harnischfeger

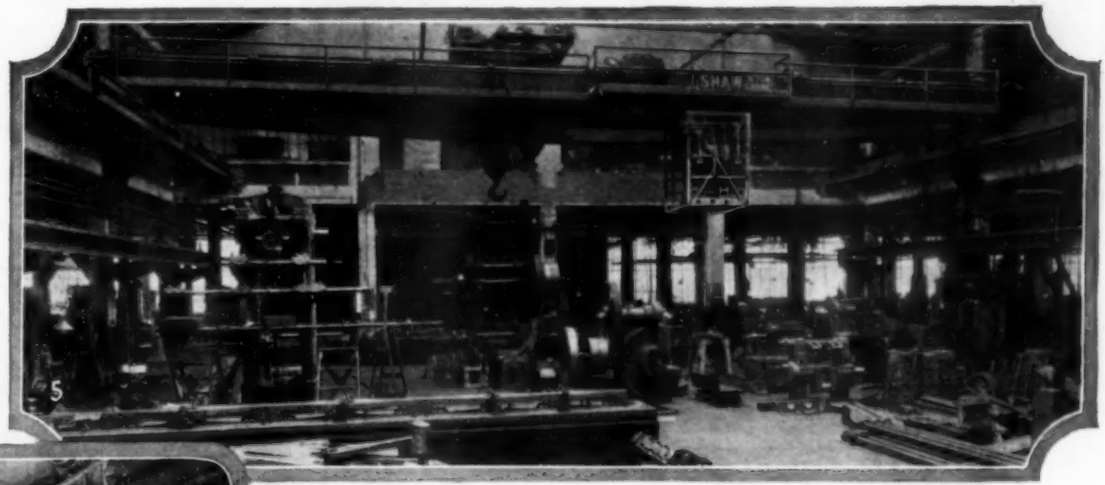
2—A 5-ton crane—Shepard

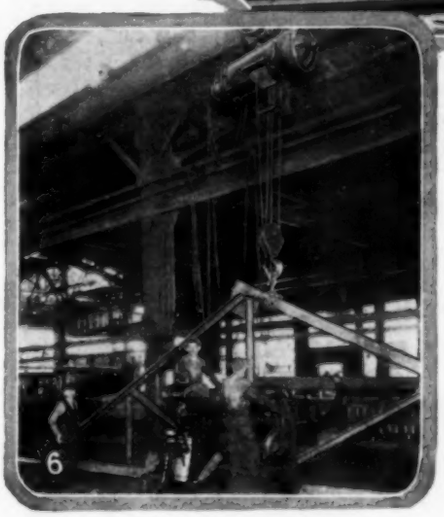
3—A 25-ton locomotive crane—Brownhoist

4—A 200-ton crane with a span of 77 ft. 3½ in., lifting a locomotive in a southern railway shop—Harnischfeger



and out of the Shop





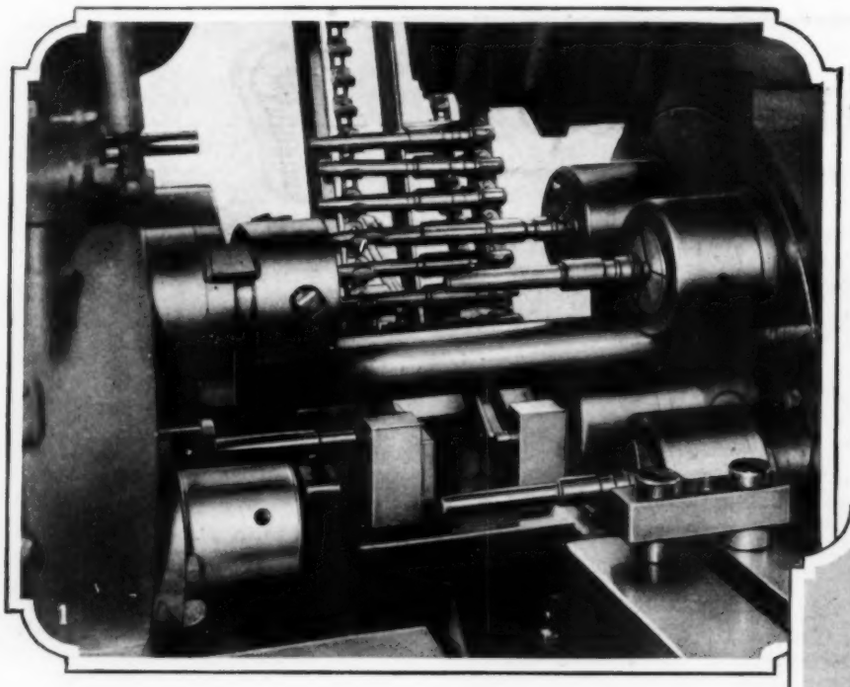
5—A 30-ton crane in large machine shop—Shaw

6—Pit-riveter hoist—remote control—Shepard

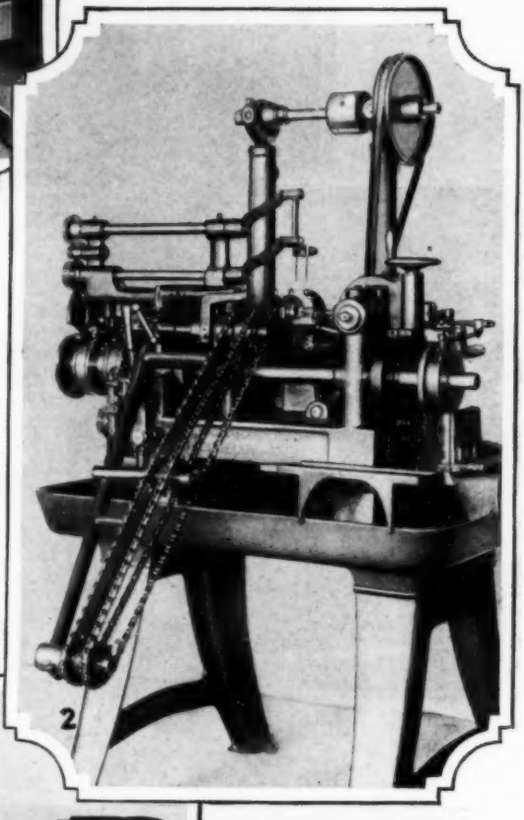
7—Two 5-ton cranes in electric shop—Whitting

8—A 7½-ton crane in a machine tool shop—Shaw

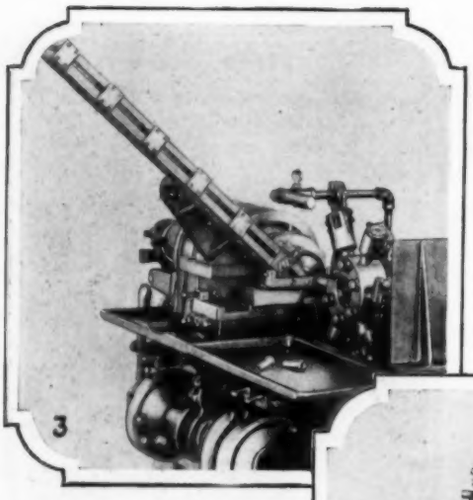
Magazine Feeds



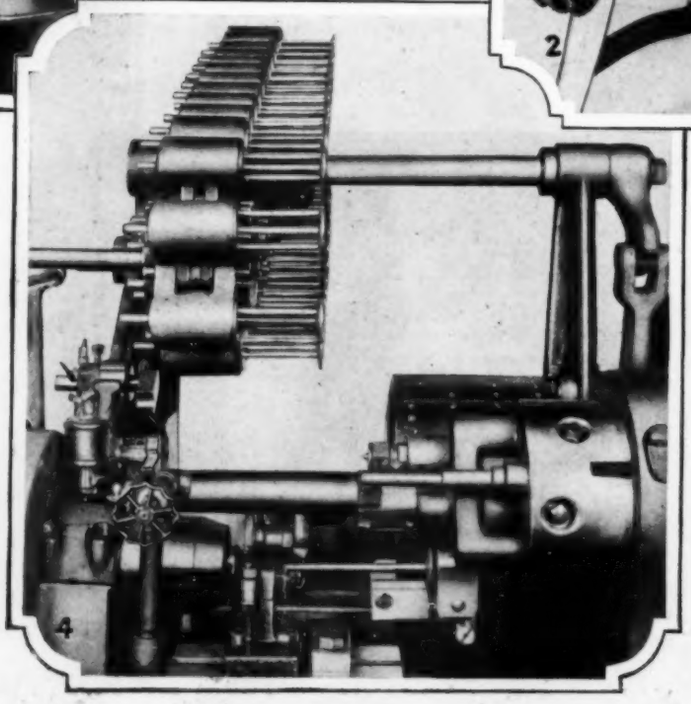
1 — Chain-conveyor feed on National Acme automatic



2 — Automatic feed by inclined chain on Davenport automatic



3—Inclined magazine on Brown & Sharpe automatic



4—Rotary, tilted magazine on Cleveland automatic

Modern Tooling Methods for Turret Lathes

By M. E. Lange
Production Engineer, The Warner & Swasey Co.

Problems of chucking work—Reducing tool and set-up time—Increasing production with combined cuts, multiple cuts, and rigid tooling—Chucks of different types

THE problems of chucking work in the average shop vary with the type of work, the material used, the accuracy required, and the quantity produced. In addition to the problems of bar work, which have been discussed in a previous article, chucking work requires careful consideration of holding devices, and the application of the principles of quantity-lot methods to the average shop is a little more difficult.

The methods used for successful quantity-lot production of chucking work include special holding devices, which of course pay for themselves quickly in quantity production, but are not practical under ordinary conditions. In quantity-lot methods it is also customary to use special tools in many cases to obtain a full application of the principles of combined cuts, multiple cuts and rigid tooling.

The conditions in the average shop, however, do not warrant such methods when only 5 to 100 pieces of one kind are made in a lot. Such intensive methods, suitable for quantity lots, are impossible for small or average production, and the problem becomes one of lowering costs without elaborate equipment.

The solution to the problem of economical production in the average shop, lies in the use and selection of universal types of chucking tools. These tools will permit full application of the principles of successful quantity-production, and at the same time are adjustable for a wide range of work, with low set-up time.

Such a set of tooling equipment will provide a tool for each of the customary chucking operations, such as boring, turning, etc. The set may then be used for a great variety of work, by shifting simple and inexpensive forged cutters. This equipment not only lowers the tool cost, but also reduces the set-up time as well. In fact, the necessity of highly-developed special-tool equipment, even for quantity production, may be questioned in many cases.

The problems of chucking work include the choice, not only of the right type of machine, but of the type of chuck as well. In the choice of either or both, the plain statements contained in this article should be of help to the production engineer

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The fifth article. The sixth will be published in an early issue.

In applying the universal types of tool equipment to chucking work, perhaps we may first define more clearly the aim in tooling such work.

I. *To increase the production*

1. Apply the well recognized principles of better methods, such as combined cuts, multiple cuts, and rigid tooling.
2. Choose the right machine for the job.
3. Select the best holding device warranted by the production.
4. Lay out the operations.

II. *Reduce the tool cost and set-up time*

1. Use universal types of tool equipment to reduce the tool investment.
2. Arrange the standard tools around the turret in a permanent set-up, so that the set-up time will be kept low.

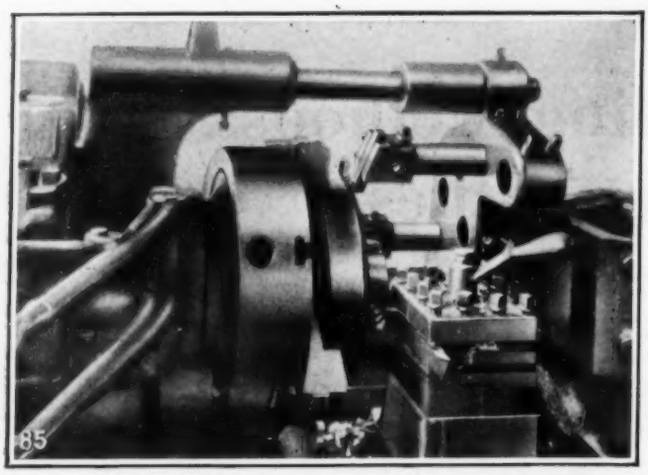
The first three articles on chucking work will explain the methods for increasing production, for selecting the right machine, and choosing the holding device. A number of typical chucking layouts will be used to illustrate the application of the principles.

Other articles on chucking work will continue, with additional examples of actual layouts. Then we will discuss the individual tools, the permanent set-up, and the final question, do better methods pay? The entire discussion will keep in mind the possibilities of reducing the tool expense for both small and quantity-lot production.

The basic principle of combined cuts, from both the square and hexagon turret stations at the same time is shown in machining the gear blank, in Figs. 85 and 86. While the square turret is facing the gear blank, the cutters in the turning head on the hexagon turret are turning two outside diameters. This method often reduces the cutting time almost one-half in comparison with methods using only one tool station at a time.

Thus, full advantage is taken of the possibilities of the modern turret lathe. Further illustrations will show the application of this principle to chucking work just as has been done to bar work.

The principle of multiple cuts is illustrated in Figs.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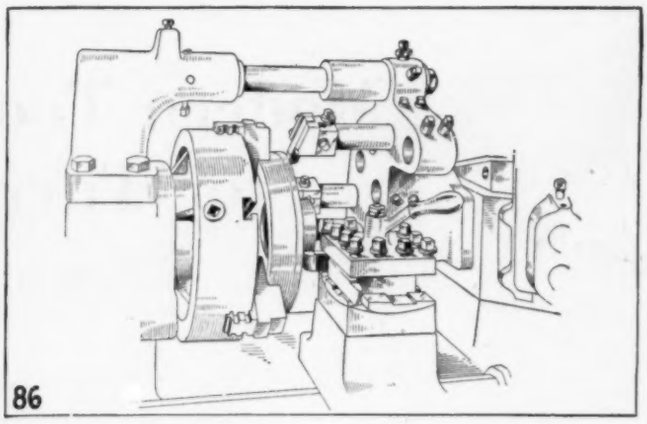
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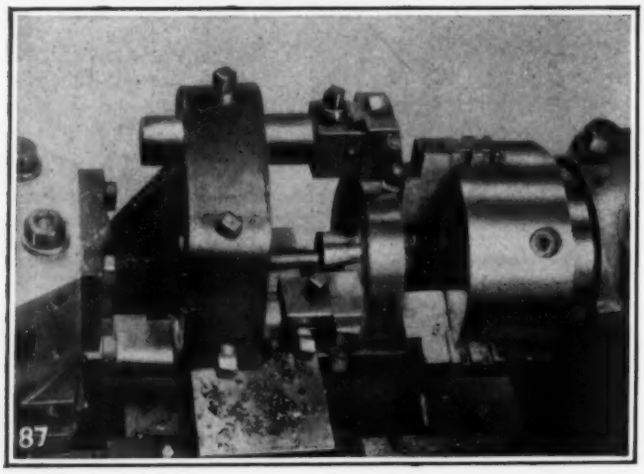
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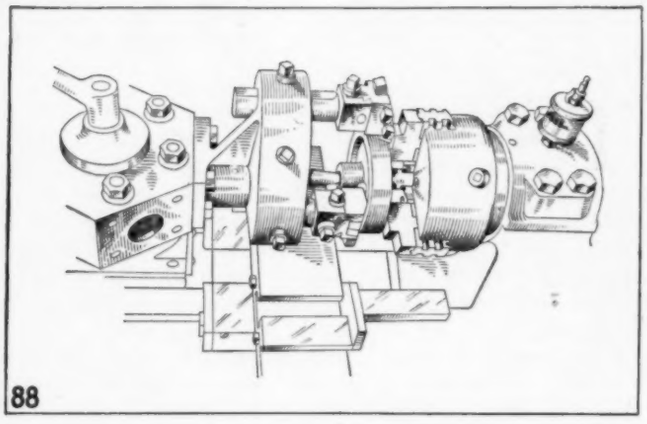
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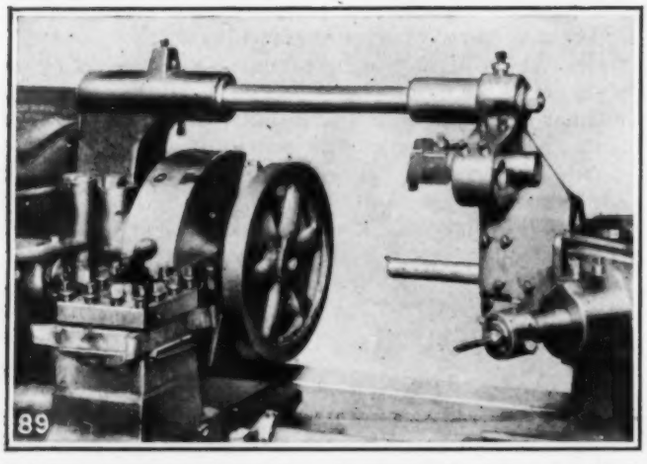
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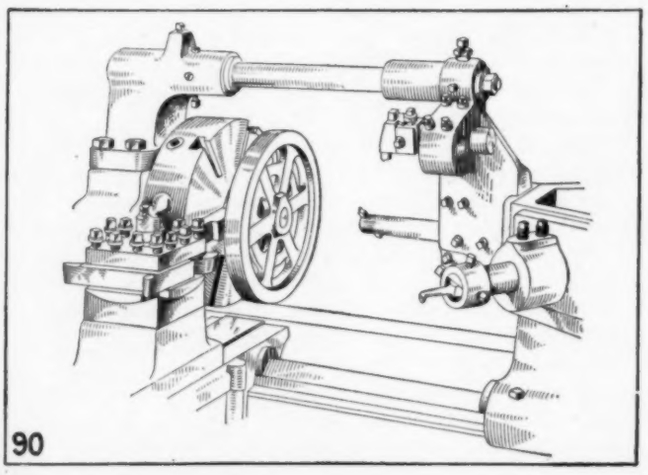
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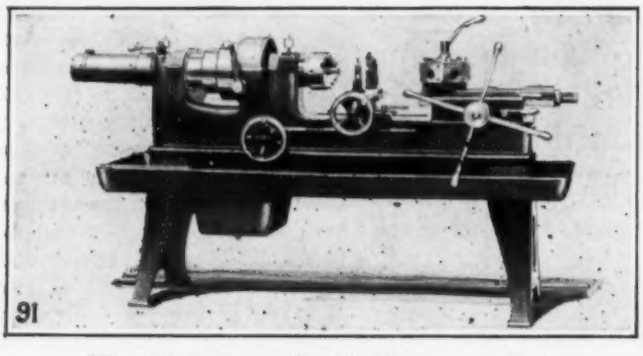
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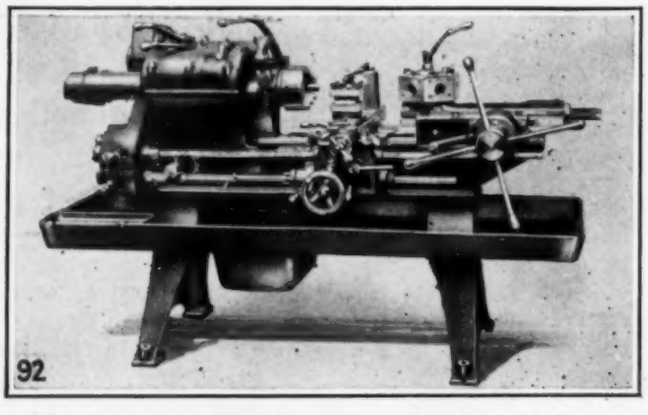
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Figs. 85 and 86—Combined cuts on chucking work. Figs. 87 and 88—Multiple cuts on chucking work
Figs. 89 and 90—Overhead piloted tools. Fig. 91—Ram-type machine with cone-head drive
Fig. 92—Ram-type machine with universal carriage and all-geared head

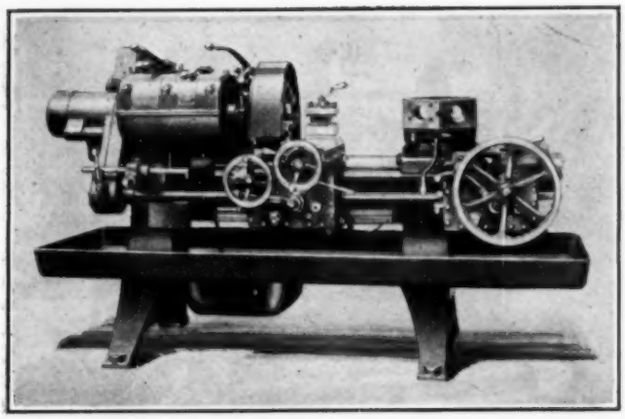


Fig. 93—Sliding-saddle-type machine with universal carriage and all-geared head

87 and 88. While the two cutters, held in the multiple turning head, are reducing the two outside diameters, the forged boring cutter, held in the same tool, is cutting the hole. Thus three cuts are operating at the same time from the same tool.

The wide application of multiple cutting principle to chucking work will be shown, including examples of the combination of multiple and combined cuts at the same time. The possibility of taking multiple cuts from the cross-slide will also be illustrated.

The principle of overhead piloted tools is to obtain rigidity for heavier feeds, as illustrated in Figs. 89 and 90. The turning head is mounted on the hexagon turret and supported rigidly by the overhead pilot. This arrangement makes it possible to use inexpensive stub bars for boring the center hole, instead of making highly-special, center-piloted boring bars.

The application of rigid tooling for medium or heavy work will be shown later, with particular emphasis on reducing the tool cost for such work produced in either large or small lots.

After the size of the machine has been determined, which is governed by the swing required by the work or the chuck, the question of what type of machine to select, arises.

Chucking work usually requires a number of different speeds for the different diameters to be turned, and often considerable power is necessary. Hence, an all-gear-driven type of turret lathe, which has a range of twelve spindle speeds without belt shifting, is often used. Sometimes the power delivered, rather than the swing over the ways, will determine the size of machine best suited for the job.

When the work is light or simple, or when the spindle speed is seldom changed, the cone-type head, Fig. 91, is often used to reduce the machine investment. Many times, even when the work is simple, the all-geared type, Fig. 92, is selected because of its easy adaptation of motor drives. The use of this type makes it possible to move the machine about easily as a unit, and provides better lighting conditions for the operator.

The ram type of machine is best suited for fast and relatively light work. It is a quick and accurate producer for quantity lots, and at the same time is suitable for a large variety of small-lot work. The sliding-saddle type, Fig. 93, is used for large and heavy work, because its construction gives a firmer support to the turret. Since the saddle slides on the bed, it also can accommodate longer work.

The universal carriage provides opportunity for combined cuts, by giving power feed to the cross-slide along the bed, either toward or away from the head. This type of machine is often used for chucking work in preference to the one with a plain cross-slide, except for simple chucking jobs that require only one facing, forming or necking position.

In tooling a chucking job, the first question is that of holding devices. The variety of work presents many problems and it is very important to reduce the time of chucking, holding the piece rigidly and accurately for heavy cuts, but avoiding the expense of special devices of limited application.

A careful comparison made of the time saved by special devices, made at an extra cost, will show that in many cases a standard devices is the most economical when the quantity of work per lot is considered. Therefore, the first effort in selecting holding devices is to try to utilize standard chucking devices. While special jaws are often necessary for long, frail, or irregular work, the use of adjustable backstops with standard jaws will often provide rigid and accurate holding without extra expense. If the quantity of work is large, the air-operated or wrenchless chuck, will quickly pay for itself through the savings in chucking time. Where it is necessary to provide a special mechanism for gripping work of irregular shapes, standard holding devices may often be used as a base for a special fixture, thus cutting down the cost.

The general field of two-, three- and four-jaw chucks is well understood, as is the use of extra-capacity collets for holding work larger in diameter than the capacity of the spindle. Our first discussion, therefore, will concern the relative advantages of geared scroll chucks, wrenchless chucks, and air-operated chucks. Then chuck jaws for various kinds of work will be considered. Finally, a brief section will show how it is possible to develop special holding devices where needed with simple and very inexpensive types of fixtures.

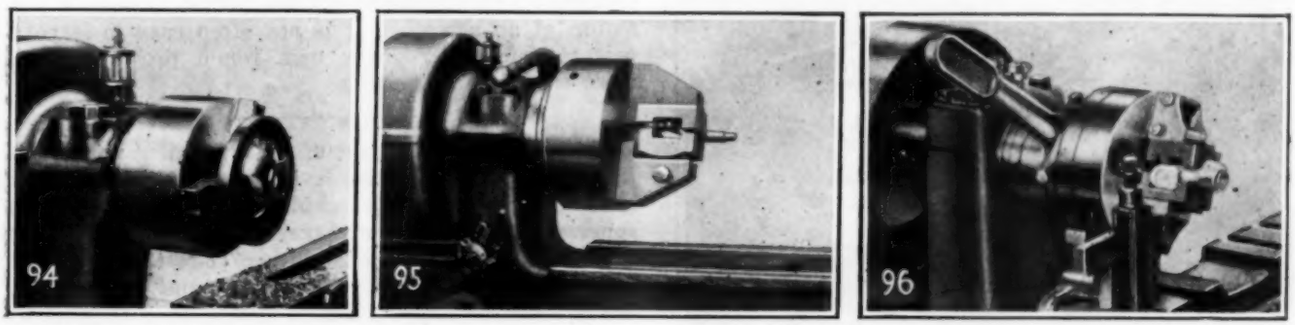


Fig. 94—Wrench-operated chuck. Fig. 95—Air-operated chuck. Fig. 96—Wrenchless chuck

The widely used three-jaw chuck, Fig. 94, is usually of the geared scroll, universal type, where all jaws move together. This may also be had in the combination type where the jaws may either be moved independently or together. Three- or four-jaw chucks may also be obtained in the independent type, where each jaw is moved independently by means of a screw.

The Air-Operated Chuck

Where air, with pressure from 60 to 100 lb., is available, the air-operated chuck, Fig. 95, is a quick-acting and rigid tool that requires very little exertion on the part of the operator. While the cost of installation and operation is greater than with the scroll type, the air chuck has a wide application and increases production where the handling time is a large part of the total machining time.

The wrenchless type of chuck, Fig. 96, also makes quick chucking time possible, with a somewhat lower tool cost than with the air chuck. After the roughing cut, the gripping pressure may be reduced so that the problem of distortion on light work may be controlled better than with the air chuck.

The wrenchless chuck, Fig. 97, is opened and closed by a hand lever, operating a cam, which in turn moves the jaws. The cam has two ranges, a steep range for quick movement of the jaws when loading, and a slow range for tight or final gripping.

The time for chucking is greatly reduced, and the lessened physical strain on the operator also increases production. Since no external power, such as air, is required, and since the mechanism is not bulky, the installation and operating cost of this chuck is less than that of the air chuck. Chucks of this type can also be had with external and internal gripping combined in the one chuck. It is possible to grip hard or lightly at the will of the operator while the machine is in motion. The center of the chuck is open, and hence pilot bars and the work also can be run into the spindle.

The jaws of a wrenchless chuck have a total movement of less than one inch per jaw for a given size when the lever is moved through its whole range. Hence, the wrenchless chuck can even be used where it is necessary to reach over larger diameters to get to the gripping surface.

A limitation is the inability of this type of chuck to hold rough forgings having much variation in size, since the gripping range per jaw is only about $\frac{1}{16}$ in. There is also a limit to the speed at which chucks of this type can be revolved constantly without the possibility of rapid wear to the operating mechanism.

Fig. 97—The wrenchless chuck in use

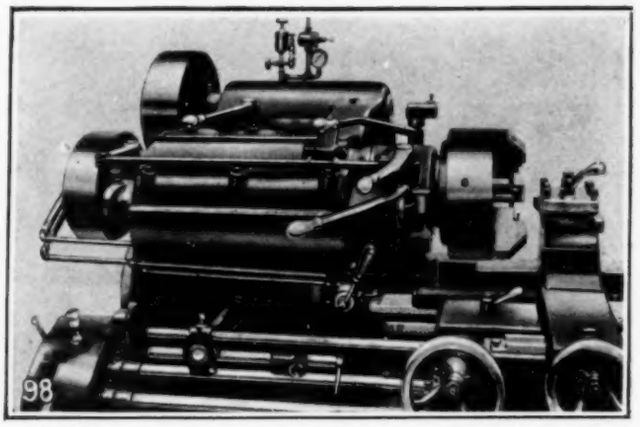


Fig. 98—Application of the air chuck

The air chuck is opened or closed by an air cylinder located on the end of the spindle, and controlled by an air valve, Fig. 98. An air supply of from 60 to 100 lb. pressure and free from water, is necessary for satisfactory operation. This type of chuck can be used for external or internal chucking, and the majority of the work can be loaded without stopping the machine. The construction is very sturdy and compares favorably with the heavy scroll chuck.

The air chuck is very quick and requires no effort from the operator. The ease of operation makes it very suitable for the rapid handling of light- and medium-weight work, when the chucking time is a large part of the cutting time, or for the loading of very heavy work. Generally speaking, it is not economical to operate one such chuck in a shop unless a plentiful supply of air is already available.

The actual movement of each jaw of an air chuck for a given size, is only three-eighths of an inch per jaw. This limited movement prevents the application to work where it is necessary to reach over a large diameter to get to the gripping surface. However, the entire range of movement can be utilized for gripping, and slippage, due to heavy and intermittent cuts, will not loosen the hold.

The air chuck can be run at all practical speeds, and while somewhat more expensive than the wrenchless chuck, it also has a wide application.

The seniority rule on railways was designed to give the older men, who had served long and well, the easiest runs. No one can find any fault with such intentions. But it works out a little oddly in these days of the gasoline locomotives that are being used on what used to be considered the easy runs. The men who were brought up on steam engines are turned loose on a gas motor, at an age when it is not often easy to learn a new technique. Younger men would probably learn more easily in most cases.

It is a fundamental part of the equipment engineer's job to keep pace with the development of equipment as it is announced in his technical paper. Perhaps the superintendent, works manager or even the president has the equipment responsibility. Then the statement may be applied to him. No matter who has the last word, other department heads should keep themselves informed so as to be capable of acting in an advisory capacity.

Ideas from Practical Men

The department, "Ideas from Practical Men," is devoted to the exchange of information on methods useful to the machinery industries. Its scope includes all divisions of the machine building industry, from drafting room to shipping platform. Descriptions of methods or devices that have proved their value are carefully considered, and those published are paid for. The rates are from five dollars upward, according to their merit

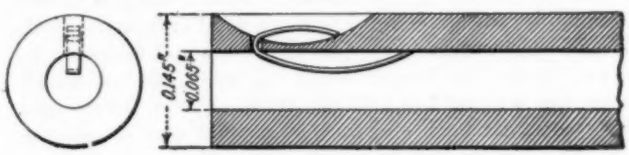
A Resist for Solder

BY W. G. AULMANN

Some tension springs, projecting into the insides of tubes 0.065 in. inside diameter, were to be fastened in place by soldering them to the outside of the tubes. Holes for the springs to pass through, and grooves to hold the spring ends and the solder were put in the tubes, as shown in the sketch.

In applying the solder, it ran down the outer end of the spring into the tube and stiffened the spring so it would not act properly. After considerable experimenting, we put a drop of silicate of soda in the end of the tube, applied the flux and solder to the groove, and heated the tube near the end. The steam from the silicate of soda blew into the tube and around the spring, leaving on the spring a deposit that was a perfect resist for solder.

We found that if the silicate of soda was put too near the end of the tube, and the tube heated inside



Spring soldered in tube

the silicate, the steam would all blow outward, but if the silicate was put into the tube a little way from the end and the tube heated at the end, the steam would blow into the tube and onto the spring.

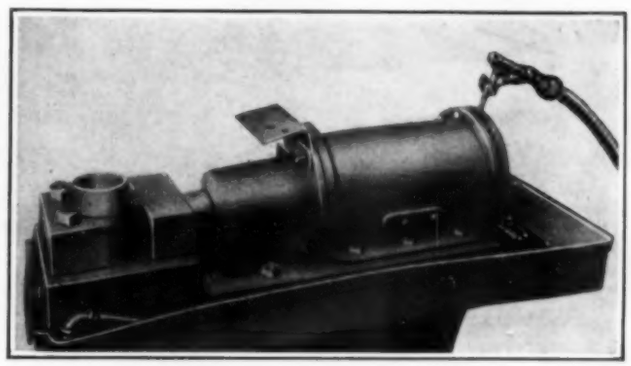
This kink may be valuable in many lines of work where a local resist for solder is desirable.

An Air-Operated Vise

BY MILTON WRIGHT

While looking around a railroad repair shop the other day, I came across a device to hold small round pieces while drilling them, or for any other purpose that requires a strong grip. The device was made of parts that were available in the shop and therefore did not cost much to make.

It was located on a metal bench beside a radial drilling machine, where the arm of the latter could be swung over it at any time, but could be moved about the shop without trouble if needed elsewhere. It is ready for business anywhere that connection can be made with the air mains of the shop.



An air-operated vise

The illustration shows about all that is necessary to know of the device. It consists of a fixed vise-jaw, firmly anchored to one end of a base casting, on the other end of which is an air-brake cylinder. The movable jaw is fixed directly to the piston rod. The whole device rests in a cast-iron splash pan, so that compound or oil may be used on the tools when desired.

A hand-operated valve admits air pressure behind the piston to grip a piece of work and exhausts it when the work is to be released. A coil spring around the piston rod forces back the movable jaw to open the vise. The grip compares very favorably with that of a screw-operated vise and its action is almost instantaneous.

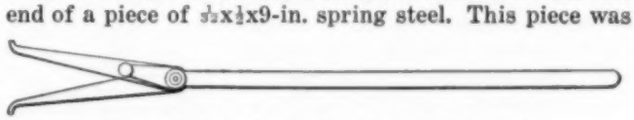
An Extension for Calipers

BY V. HERMAN

I had a number of 1¾-in. holes, 13-in. deep to bore. The work was done in an engine lathe and the outer end was supported in the steadyrest.

Finding a pair of 12-in. inside calipers rather heavy and inconvenient for use in calipering the back end of the hole, I made an extension for a pair of 4-in. calipers, as shown in the sketch.

To make the extension, I drilled a ¼-in. hole near the end of a piece of $\frac{1}{32}$x½x9-in. spring steel. This piece was



Extended calipers for deep-hole work

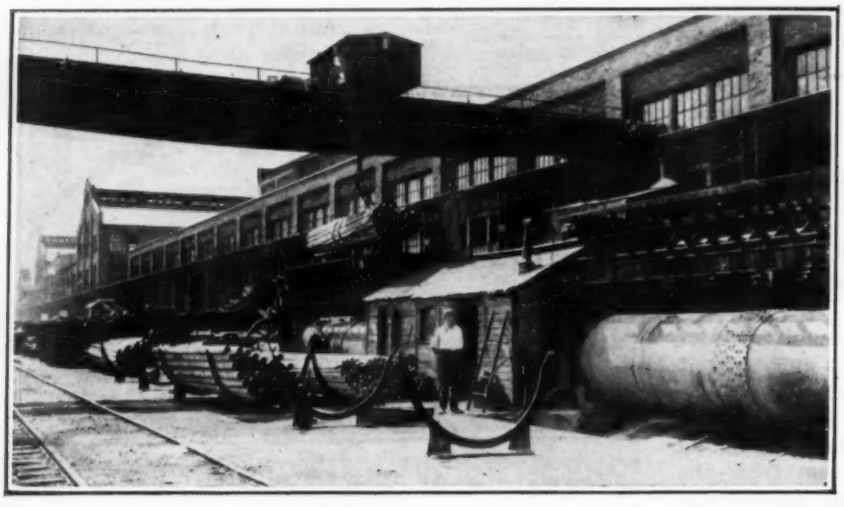
put over the screw of a pair of 4-in. lock-joint calipers and the nut tightened down on it. The extended calipers worked very satisfactorily.

Rattler for Cleaning Locomotive Flues

By I. B. Rich

The flue-cleaning plant of the Big-4 shops at Beech Grove, Ind., is built out of doors, beside the main buildings, as shown. The flue rattlers are above ground, instead of being depressed, as in some cases, the flues being dumped in at the tops and emptied out at the bottoms.

The illustration shows a bundle of flues being lowered into the hopper, which is a steel framework built over each rattler. With the doors open the flues can be dropped into the rattler at will. After rattling they are dumped out on the incline shown, and then picked up by the crane and placed in the racks in front, to be taken to the erecting shop when needed. The rattlers are served by the same crane that handles materials stored in the yard.



Flue rattlers, loading frames and storage racks

Trying Out Solid-End Main Rods on Old Locomotives

By Frank C. Hudson

In order to try out floating bushings on the back ends of the main rods, the Grand Trunk Railway, in common with a few other roads, is putting special, solid ends on the backs of the main rods. The details, from the Battle Creek shops, are shown in the accompanying illustration.

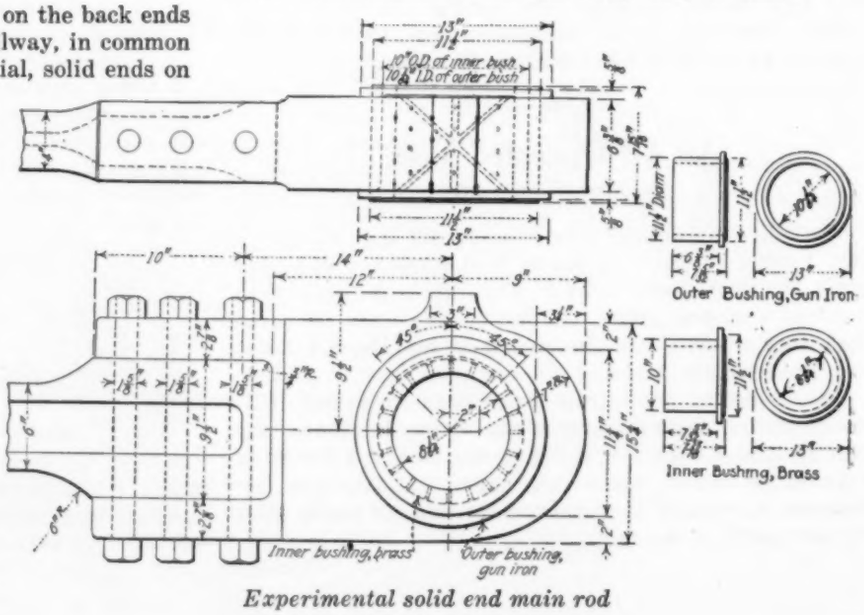
The new end is a forging, machined to fit over a regular rod after it has been shortened the desired amount, in much the same way as the straps formerly fitted over the rod to hold the brasses in place. The crankpin in this case is 8 in. in diameter, and the floating bushing is an inch thick, less the $\frac{1}{64}$ in. for clearance on the crankpin. Another bushing, 11½ in. outside, and made of gun iron, is pressed into the rod end, as a bearing for the bronze inner bushing. The inside diameter of the iron bushing is 10$\frac{1}{64}$ in., allowing $\frac{1}{64}$ in. clearance each side of the floating bushing. This is fairly common practice in floating bushings in main rods, although they are frequently larger in diameter than this.

There are 9 rows of 10 holes each in the floating bushing, the holes being ¼ in. in diameter and countersunk ¼ in. deep on the outside. The holes are packed with grease before the rod is put on the pin. The inside of the outer bushing has transverse grooves ½ in. wide and ⅛ in. deep across the bearing, and angular grooves are ¼ in. wide and $\frac{7}{16}$ in. deep.

It is important that the new rod end be fastened rigidly on the old rod, so the three 1⅝ in. bolts are made a drive fit, the nuts are case hardened and the ends of the bolts riveted over. One of the difficulties experienced on some roads has been the loosening of this false, or special rod end. Just how much this would affect the running of the floating bushing would probably depend on the amount of looseness in the rod.

The amount of clearance given between the pin and the bushing and also between the two bushings seems excessive at first glance, but it appears to be common practice. A total clearance, or oil allowance of $\frac{1}{32}$ in. seems hardly necessary and we might expect the rod to be noisy. In practice, however, this clearance seems to work out well on a number of roads, and it is quite probable that the large diameter, combined with the rolling movement of the bushing around the pin, gives a very different effect than would a smaller bearing with the same clearance. The solid-end main rod seems to be on its way to join the solid-end side rods, against which there was a great howl thirty years or more ago. And this makeshift back end may be a good way of getting the necessary experience without building new locomotives or making complete new rods.

The use of solid-end main rods is one of the many steps that are being taken to eliminate unnecessary adjustment and to secure better service from locomotives. Solid bushings are also very easy to make.



Experimental solid end main rod

Blanking-Die Data

When laying out work for a plain or a progressive blanking die, it should be remembered that one side of the blank produced will have sharp edges and the edges of the other side will be rounded. When the blank is assembled to other units, it is advisable to have the side with the sharp edges located next to the assembled part. The part drawing should specify which side is to have sharp edges so the die layout can be made accordingly. In cases where either side can be used, the layout can be made for the best run to suit the shape of the blank. The side with sharp edges lies next to the punch, and the side with rounded edges next to the die. Exception is made when the blank is to be formed, in which case the side of the blank with rounded edges should be next to the forming die.

In a layout for blanking from strip stock, it is good practice to allow a distance between blanks, and between the blanks and the edges of stock, equal to the thickness of the stock as shown in Fig. 1 at *A* and *B*.

The amount of material to allow around the contour of the blank for shaving, depends largely on the nature of the metal being blanked. A general rule is as follows: For a single shaving operation, allow approximately 0.003 in. for each $\frac{1}{32}$ in. of blank thickness. For two shaving operations allow 0.002 in. for each $\frac{1}{32}$ in. of blank thickness for the first shave, and from 0.001 to 0.0015 in. for the second, keeping the ratio about 2 to 1.

When making a progressive blanking die, as shown in Fig. 2, a distance equal to the thickness of the blank should be allowed between the various punches. This method, called step-punching, distributes the pressure over a greater length of the press stroke rather than applying all the pressure at once.

Die-blocks should be made large enough so that spreading or cracking will not occur. Fig. 3, at *A*, shows a die having rounded corners in which the distance from the die opening to the outer edge is $1\frac{1}{2}$ in., minimum. When the die has sharp corners, as at *B*, a greater distance, should be allowed.

The openings of die-blocks are generally made taper, as shown in Fig. 4. At *A* is shown a die having a straight portion next to the face, beyond which it has the usual taper. At *B* the tapered portion is started from the die face. The angle of taper is usually $\frac{1}{2}$ deg., although for some work 1 deg. may be used. After the die face has been ground down, making the opening too large, the die can be reconditioned by annealing, peening and rehardening.

For double-run die work, including a single run along one edge of the stock, after which the stock is turned end for end and a single run made on the opposite side, the procedure is similar to single-run dies. When double blanking dies are required, the distance between the blanking punches should be made to suit the work. If the distance is too small, the die block will break down between the opening. A safe minimum distance is $\frac{1}{16}$ in. This rule applies to all multiple-punching operations.

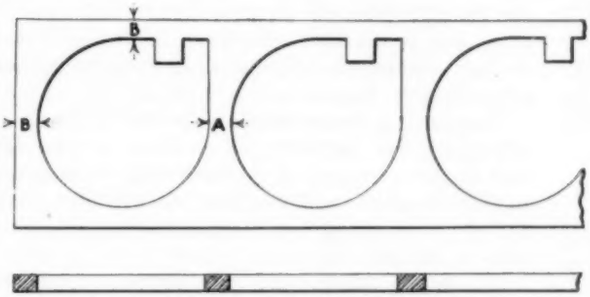


Fig. 1 Amount of Metal to Be Left Between Punchings

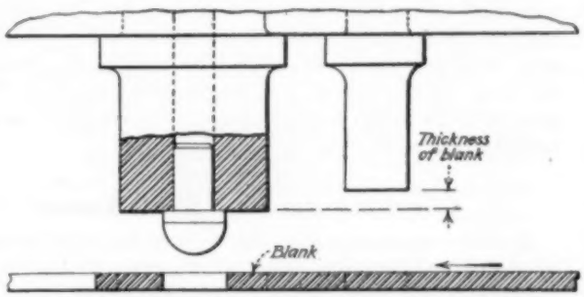


Fig. 2 Arrangement of Punches for Progressive Work

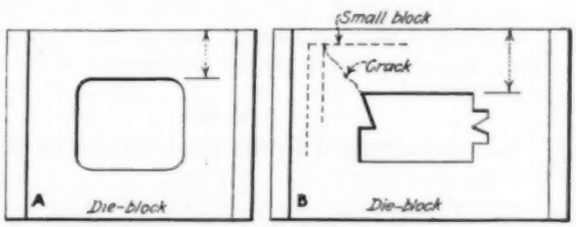


Fig. 3 Thickness of Die-blocks Around Openings

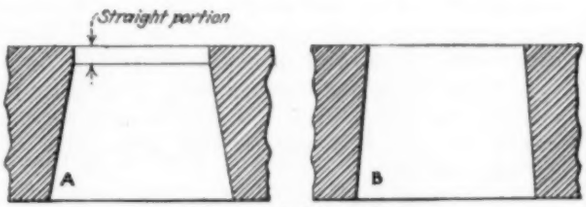


Fig. 4 Die-block Openings

All blanking dies should be provided with stripper plates and guide plates. If two guide plates are to be used, one on each side of the stock, be sure to make allowances for variations in the width of the stock, also for the spreading of the stock due to punching. The application of a flat spring on one stripper plate is good practice. A liberal clearance can be made between the stock and the stripper plate. For blanks that require to be bent, use the rules shown in the reference-book sheet on page 285, Vol. 63, of the *American Machinist*.

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Practical Shop Problems

Questions of a Practical Nature will be answered in these columns

Strength of an Aluminum Gear

Q. We desire to know how a 255-tooth, 5-pitch, 1¼-in. face aluminum-alloy gear will wear when driven by a 160-tooth, cast-iron gear at 300 r.p.m. The pressure at the pitch line at full speed will be comparatively light, probably never over 30 lb. When the machine is being stopped, which does not happen frequently, it might reach 300 or 400 lb. The aluminum alloy used in the gear material consists of 2½ per cent copper, 10 per cent zinc, 2 per cent impurities and the balance aluminum.

A. Aluminum and its alloys have certain properties, such as a low modulus of elasticity and a relatively high compressive strength, which should make it a good material to resist wear in gears when running with cast iron. On the other hand, it has other properties, such as its tendency to abrade and "gum up" when very much sliding exists, which would tend to limit its usefulness in this field.

However, for gears of the size you mention, 5 pitch with 255 teeth, the amount of sliding will be very little, and this material should prove satisfactory when running with the cast-iron gear. Its maximum space load for wear at the speeds you use should be about 700 lb., provided the teeth are suitably lubricated and are protected from abrasion.

Checking the Line Shaft Losses

Q. We have been told that we are losing a good deal of power in line shaft friction in our various production departments. We cannot believe that this is so, since we have never had a burned-out bearing that we can remember, and the line shafts have never needed attention other than regular oiling. Do you believe there can actually be much loss in this respect?

A. In order to find out just what it is costing you to run the line shaft, it is a simple matter to connect a meter and get a power reading from each of your driving motors.

We suggest that you do this first with all of the machines running idle on the shaft. Then take readings as the belts to the machines are thrown off, one at a time. The final reading will then be taken with only the driving motor connected to the shaft. If it is practical, it would also be a good plan to take readings, while all the machines are connected to the line shaft, on the power required while each machine is at work as well as while it is running idle.

With these readings, you can compute the power figure for useful work on each machine, that used to drive each machine idle and that required just to turn the line shaft over. We venture to say that some of the results will be surprising. If you have not checked the alignment of your shafts recently, they will probably be taking more power than you may now estimate. Buildings settle and floors get out of line so that a periodic check on alignment is very advisable. Then, too, if the hangers have become loose there will be a good deal of bending in the shafts when loads are thrown on and off. If the shaft bearings are of the ball or roller design, the losses will be less, of course, but even this does not lessen the advisability of attaching the meter at stated intervals to know what condition exists.

The actual time required to make the test is negligible compared to the advantages that will accrue from knowing the actual conditions so they can be corrected if necessary.

Equipment Operated by Engine Suction

Q. I propose to build a machine on which an air suction will be used under about the same conditions as exist in an automobile intake. I expected to also use the discharge. The opening possible will not give sufficient volume, and I need to know if a weighted valve in the suction line will be objectionable.

A. We judge that you have in mind an attachment for an automobile engine, and want to advise you to proceed very carefully.

Restricting the intake in any way will have a serious effect on the intensity of suction at the carburetor, and on the amount of mixture that each piston of the engine is able to draw into its cylinder. The result will be that the present arrangement will go seriously out of balance.

If, on the other hand, you have a reciprocating machine that does not include a piece of apparatus, such as a carburetor, you can build up the intensity of suction by placing a restriction on the intake to a point equal to the ability of the machine to act as a vacuum pump.

Limit to Speed Reduction on Press Flywheels

Q. What is the greatest reduction of speed that can be safely allowed in a press flywheel while making a hit on the press? Is there any difference in this limit for belt-driven and direct-driven presses?

A. For belt-driven machines, the limiting low velocity is the speed at which the belt will be liable to run off the pulley. Experiments have been made which show that this takes place when the belt slip exceeds 20 per cent of the belt speed.

For direct-driven presses, there is of course no factor of belt slippage to consider, and the limiting factor here is the overload that the driving motor can safely handle as a comparatively short peak load. This limit is, of course, dependent upon the make and design of the motor and is a point on which the motor manufacturers should be consulted for any specific case.

Technical Abstracts

Inspection at Schenectady

W. W. Wagner, chief inspector of the General Electric Co., at the Schenectady Works, says his department may be called a clearing house for rejected materials received from outside suppliers and for defective work done within the plant.

In cases of defective work done within the plant, the inspector is of invaluable aid to the foreman in charge of that work. The relationship between the two is a novel one. The mechanical inspection department, while a part of the manufacturing organization, reports directly to the general superintendent and is purposely kept independent of the management of the local manufacturing sections. It is not planned, however, that this relationship shall affect in any way the co-operation which exists between foreman and inspector. Rather it is the object to keep these two persons in close contact and to bring the foreman to feel that the inspector, instead of a chronic faultfinder, is a real asset to his organization.

In shops where it is necessary to maintain a regular force of inspectors, men are selected for the work who have had a broad mechanical training. In the performance of his routine duties the inspector finds many opportunities to suggest changes in the construction of apparatus, hoping to obviate some of the difficulties or defects which develop during the process of manufacture and thereby saving unnecessary labor operations. The result is a tendency to decrease manufacturing costs. In making such suggestions he works in harmony with the engineer, the foreman and the assistant foreman.

The ideal inspector is not too ready to condemn work for defects which may be insignificant and relatively unimportant and which may be easily corrected without an undue expenditure of time and material. Good inspection does not necessarily involve the wholesale condemning of detail parts that do not exactly measure up to the drawing. Small variations frequently do not affect the mechanical efficiency or sale of apparatus, and it is here that the inspector must employ wisdom and judgment.—*Industry Illustrated*, Jan., 1926, p. 58.

Production Development

John H. Van Deventer begins a series of articles in which he will discuss the mechanical efficiency of automotive manufacture. Today you can buy a better motor car than you could in 1913 for 30 per cent less money. This miracle of efficiency has taken place quietly and quickly —so quietly and so quickly that most of us have failed either to recognize the fact or its significance. Far-seeing and open-minded industrial executives in other fields are asking themselves "What can we learn from the automotive industry?" In reply to a questionnaire some executives of the industry have said that standardization and production is the leading lesson.

Both general and specific standardization in the automotive industry as a whole (outside of the factory) have still a long way to go before they reach their limit. If there is still room for improvement in the automotive industry in this respect, there is much more room for it in other industries, particularly in other branches of the metal-working industry. Standardization within the individual factory, and its effects, are much more obvious than that outside of the factory and within the industry as a whole. Briefly, in the automotive plant this consists in the selection of from one to perhaps three chassis with a variety of body styles, the rigid standardization of component parts and in production and assembling.

The price trend is downward and how long the weaker concerns in the industry can keep step with these price reductions is a question. It is a swift race and a fast one for some concerns which have not yet attained their "second wind." Considered as a whole the industry is one of exceptional vitality and its average pace in the efficiency race will increase for many years to come.—*Industrial Management*, Jan., 1926, page 1.

Industrial Lighting

Surveys indicate that, judged on a basis of present day ideals, there is still a tremendous field for lighting betterment in American industry. Less than 20 per cent of the country's factories, according to W. H. Rademacher of the Edison Lamp Works, possess illumination which is in accordance with present day recognized standards. There has been a constant tendency toward the application of higher foot-candle intensities. For medium work there was recommended four and five foot-candles of illumination in 1910 and in 1925 the recommendation ran up to between six and twelve.

The question raised is why this increase is needed today for a given operation if one-half was used fifteen years ago. The general answer is that it is found that the increase brings production under a high level of illumination—the eye perceives more accurately, more rapidly and with less fatigue than under the low level of illumination and this quickening of vision is accompanied by a speeding of movements on the part of the workmen. For example, pulley finishing increased 35 per cent with only a 5 per cent additional light cost in percentage of payroll. Experiments are still being made in this field.

It is obvious that an automatic machine cannot be speeded up nor its output increased by merely supplying it with more light. Again the experienced operator who has arrived at a point where he works almost automatically will not be benefited to any great extent by light increase and there is also the physical capacity of the worker to be taken into consideration. If an operator under three foot-candles of illumination is moving as rapidly as is physically possible, an increase in intensity, no matter how great, cannot bring about a production increase. It is quite obvious therefore that an increase of illumination will not necessarily bring about increased production, but it is clear that a study should be made of the possibilities.—*Society of Industrial Engineers Bulletin*, Jan., 1926, p. 17.

American Machinist

KENNETH H. CONDIT AND FRED H. COLVIN
Editors

Established 1877

When Is a Machine Obsolete?

OBSOLESCENCE, in the modern metal-working plant, is much more apt to be the cause of equipment retirement than actual wear. In a few plants production proceeds at such constant high pressure that machines are really worn out, but, in general, dull times come often enough and are of sufficient duration to keep a machine good for service for a considerable period.

What determines obsolescence? Age has much to do with it, but not necessarily age measured in years. Isn't it age as measured by the introduction of the last radical improvement in machines of the type in question?

Certain types of textile machines, for instance, have not changed appreciably in fifteen years. Any individual machine incorporating the features brought out at that time can hardly be obsolete, therefore, even though it be twelve or fourteen years old.

On the contrary, domestic refrigerators, some kinds of machine tools or radio receiving sets that are more than the same number of months old are pretty sure to be obsolete although they are physically as good as new.

Figuring obsolescence on the basis of time only will hardly answer.

On Selling Machinery

TAKING a crack at the various sins of omisssion and commission perpetrated by the makers and sellers of all kinds of machinery is quite a fashionable pastime. Most of the criticisms haven't a great deal of real foundation, or at any rate the shortcomings complained of are not peculiar to the machinery industry. Once in a while, however, somebody voices a protest that is worth listening to and acting upon. For instance—a man who has bought many machine units, and sold almost as many, says that machinery is sold wrong. That it is sold the way the makers want to sell it and not the way the users want to buy it.

If the criticism is just the sellers are certainly lacking in their knowledge of psychology. Almost any successful merchant will lay much of his success to his ability to gage the wants of his customers and to understand their methods of purchasing. The merchant, of course, is out to sell his wares at a profit. He knows what they cost him and what he will have to get for them.

The machinery builder, on the other hand, is not always sure what his product actually cost, nor does he know very much about the psychology of his customers. He started as a builder or creator rather than as a trader and he still has much to learn about the latter function.

The Cost of Repair Parts

THE problem of pricing repair parts confronts every manufacturer and there seems to be no standard method of determining what is a fair price. There are so many variable factors that each must determine his own method.

Where models change but seldom, spare parts can be taken from current production and do not require storing for long periods. In such cases the parts can be priced very moderately. Where parts are desired of old models they must either be made in small quantities or stored for long periods, the cost is higher than in the first case, and the price must be increased accordingly.

It is, however, usually a mistake to price parts on the theory of charging "all the traffic will bear." A customer resents being charged five dollars for a piece that he knows can be made for twenty-five cents and nothing makes a man decide to buy some other machine more quickly than a few repair bills with parts charged for at what he considers exorbitant prices.

Fair play all around seems to be the best policy.

Vocational Training for the Sub-Normal

THE discussion of sub-normal people is a delicate question. But it is a problem that faces both the teachers and the employers, although the latter class do not, perhaps, yet recognize it so clearly as the teacher.

Vocational or co-operative courses are frequently the dumping ground for pupils who cannot keep up with the regular course of studies. Occasionally, one might almost say frequently, a pupil who does not like to study will shine in a vocational school. But such a pupil is not sub-normal, mentally. He is not a student but enjoys working with his hands. It does not take many real sub-normals to make a class of any kind appear in a bad light.

There is, however, another side to the question. For we have learned that sub-normal people can be trained to do many kinds of work well and efficiently. They possess a certain amount of skill and can learn many operations. They frequently make good operators on semi-automatic machines. Work that is monotonous to the man with a keen mechanical mind, makes them contented and self supporting. Experiments in placing sub-normal workers are being made in at least one state with successful results.

Shop Equipment News

Gardner Special Hexagon Grinding Machine, Triplex, No. 78

The No. 78 triplex grinding machine, illustrated in Fig. 1, has been built by the Gardner Machine Co., 410 East Gardner St., Beloit, Wis. It is intended primarily for grinding hexagonal spark-plug shells, but it is also adapted to other parts of a similar nature, such as hexagon nuts.

Three pairs of grinding members are set immediately behind each other on a single base. An endless chain having studs to fit the bore of the parts to be ground brings the work between the grinding wheels. The spark-plug shells are placed on these studs by hand, and they are automatically aligned for the first grinding operation. After they pass through the first pair of wheels they are automatically indexed one-third of a revolution to present the next two faces to the following pair of wheels. This operation is repeated before the shells enter the third pair of wheels, where the grinding is completed. As shown in Fig. 2, the shells are tipped into a container at the rear of the machine as they emerge from the final pair of grinding wheels.

The chain carrying the shells is driven from a jackshaft in the machine base through a wormgear reducer in order to secure the proper rate of feed. It is controlled conveniently through a friction clutch by means of a hand lever. Two operators can be used to advantage to load the chain which, it is claimed, will accommodate 7,000 shells per hour.

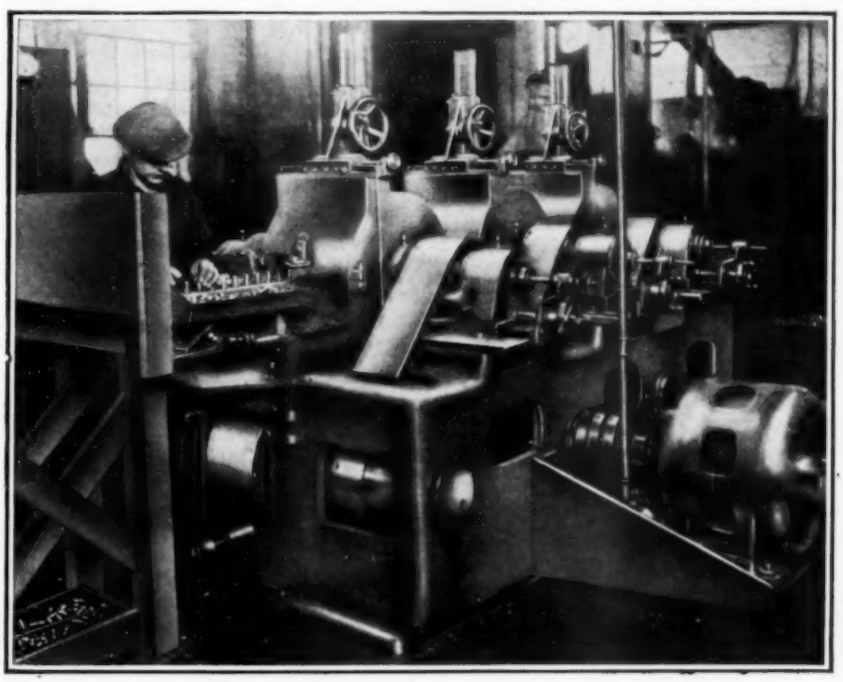


Fig. 1—Gardner Special Hexagon Grinding Machine, Triplex, No. 78

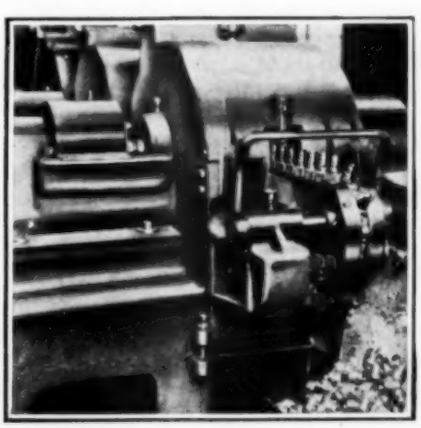


Fig. 2—Discharge end of the machine

The grinding members used are of the type previously described from time to time in the *American Machinist*, in connection with the regular line of double-spindle disk grinders produced by the company. They carry steel disks 20 in. in diam., faced with heavy-type Gardner G. I. A. abrasive disks.

Each of the six spindles of the grinder has an under-belt drive. The entire machine is driven from a 40-hp. motor which is connected through a flexible coupling to the main drive shaft. This, in turn, transmits the power to the other shafts. All spindles and the drive shaft are carried on ball bearings mounted in dustproof housings.

The grinding members are hooded and ample exhaust provision is made. A dressing device is built into each hood to facilitate truing the grinding wheels. Micrometer stop screws provide adjustment for wear.

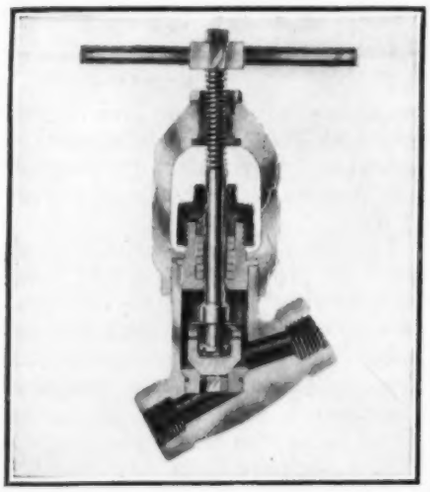
"H-P-M" High Pressure and Temperature Forged Steel Valve

The Hydraulic Press Manufacturing Co., Mount Gilead, Ohio, has placed on the market the "Forgsteel" valve illustrated, for high pressure and high temperature conditions. The valve is of the straight-way type. Its forged-steel construction is said to permit a valve body of uniform section throughout so that there will be no unequal expansion or contraction.

The steam opening is full and the path of the flow is confined to a minimum number of angles. The seat disk and the stem are of non-corroding, acid-resisting steel or Monel metal.

Ample packing space has been provided in the valve. It can be repacked quickly and without interrupting its operation. The packing nut is of Monel metal. The yoke is of steel and the stem is of Monel metal and has Acme threads.

Shop Equipment News



"H-P-M" High Pressure and Temperature Forged Steel Valve

The body of the valve is provided with heavy hexagon ends. The valve seat has a beveled seal. It is made from Monel metal and is removable. The Monel disk is renewable and a bronze bearing plate protects it from wear from the stem. The hole, which can be seen in the illustration, will accommodate a pin to lock the disk for regrinding.

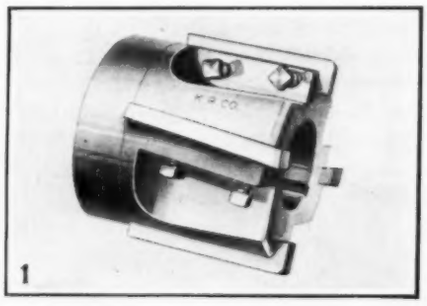
The bonnet is made from machinery steel and it is provided with a deep stuffing box. A seat on the rim of the valve body seals the pressure between the valve body and the bonnet.

The bronze packing gland is held in position by means of a Monel packing nut. The valve is designed with a long steel yoke to radiate the heat before it reaches the T-shaped handle.

Kelly Model M Cutters and Model D Reamers

A line of multiple-blade adjustable production cutters and reamers has been placed on the market by the Kelly Reamer Co., Cleveland, Ohio. The Model M cutters are designed for roughing purposes. As standard they have four blades. The bodies are made of manganese-chrome alloy steel and heat-treated. The blade slots are evenly spaced but on a right-hand spiral and sections are milled in the body to provide chip clearance. The blades are made from high-speed steel. Each is held in position by means of two square-head setscrews seated in a groove milled in the blade. Adjustment is secured by the forward movement of the blades on an inclined plane. A support screw backs up each blade so that the expansion can be secured accurately.

The Model M cutter for use on an arbor is made in sizes of from 1⅜ to 4 in., in steps of 1/16 in. The Model MA cutter, which is shown in Fig. 1, is furnished with an extra large straight-hole for line cutting. The range of sizes is from 1⅜ to 3½ in. The Model MF cutters are for chuck use and can be had with straight or taper shanks in sizes of 1⅜ to 3 in. Larger sizes of all the models can be made to order.



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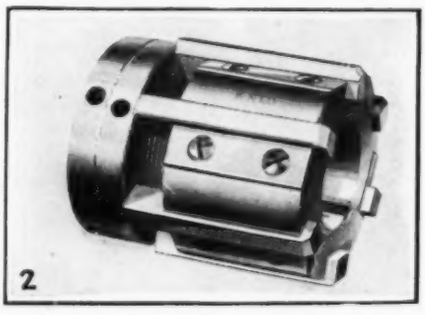


2

Fig. 1—Kelly Model MA Cutter. Fig. 2—Shell reamer for line reaming, Model DA

The finishing reamers, in all models, have six blades in the smaller sizes and eight or more on the larger diameters. The bodies are of manganese-chrome alloy steel and have the blade slots milled parallel to the axis of rotation but at unequal spaces from each other to avoid chattering. One side of the blades is tapered to fit the hardened wedges which extend from the front end of the body to the threaded section. Two heat-treated screws pull each wedge against the blade rigidly locking it.

A wide range of adjustment is provided in all the models. The rear section of the body is threaded to take double adjusting collars. Since the blades fit in grooves that are milled on an inclined plane, when the collars are screwed forward the blades are forced to expand outward and forward. The thread is of a fine pitch to provide for accurate adjustment.

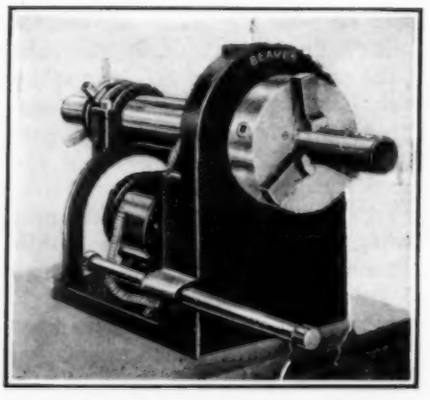
The Model DE is a hand reamer on the shank of which guide bushings can be used. The bushings are hardened and ground and can be held in any position on the shank by means of a setscrew. They are made in sizes of from 1 to 3 in. in diameter.

The Model D shell reamers for use on arbors are made in sizes of from 1 1/16 to 6 in. Fig. 2 shows the Model DA shell reamer with a straight hole provided for line reaming. It is made in sizes ranging from 1⅛ to 3½ in. The Model DF reamer for chucking purposes is made with straight or taper shanks in sizes of from 1 to 3 in. in diameter.

"Beaver" Power Drive No. 44

The No. 44 "Beaver" power drive is manufactured by the Borden Co., Warren, Ohio, and is intended primarily for pipe cutting and threading, but can be used for driving other hand tools.

The unit consists of a chuck driven through gearing from an electric motor. The motor is ½ hp., 110- to 220-volt, a.c., 60 cycle, single-phase. Motors with other specifications can be supplied. The unit is designed to cut and thread pipe of from ¼ to 6 in. The net weight is 230 pounds.



"Beaver" Power Drive, No. 44

Shop Equipment News

Besly Vertical Disk Grinder Special Adaptation

The No. 29 motor-driven vertical-spindle grinder manufactured by Charles H. Besly & Co., 118-124 North Clinton St., Chicago, Ill., has been equipped with a special fixture for grinding one side of conduit boxes. The machine is designed for removing the fins and surface irregularities of the boxes as they come from the foundry.

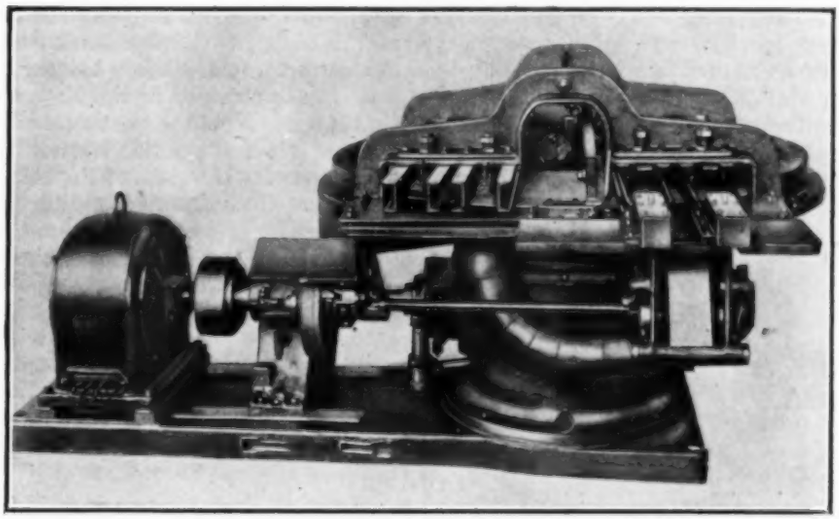
The fixture, which can be seen in the illustration, consists of two yokes attached to the outer guard-ring support. To these yokes are attached eight adjustable steel channel irons which form four work slots or guides across the top of the disk wheel. At the top of each work slot an adjustable spring pressure bar is mounted. This bar extends across the face of the grinding disk and is set to regulate the amount of pressure needed to grind the work as it passes beneath it. Two operators are required on the machine to secure its full production capacity. One operator is stationed on the right hand side in front of the machine and the second operator is stationed to the left on the opposite side. Each man has two stations to load, simply dropping the castings in the slots when the feed plungers are at full return stroke.

The power-driven feeding device is mounted at each side of the machine directly in front of the guide channels. This device consists of two shelf-type plates attached to the guard-ring support. Drive shaft brackets and reduction gear units are mounted on the underside of these plates. Each unit is driven individually by belt direct from the machine drive shaft. Friction cut-out clutches are also provided as a means of safety in case the machine should become clogged or if only one unit is operated. Each reduction gear unit is equipped with two T-slotted crankdisks to which connecting rods are attached. These connecting rods operate vertical levers having fulcrums at the lower ends on gear brackets. The top ends are slotted to operate on steel rollers secured in the slots of horizontal, steel work-feeding plungers. These are mounted in guides on the top side of shelf plates. Since the crankdisks are slotted it is possible to set the plunger stroke to the capacity required.

Each plunger is set so that one recedes while the other goes forward. An adjustable work plate is mounted directly under the projecting ends of the feeding plungers and close to the grinding disk. The plate is kept level with the grinding disk so that the work will slide on and off the disk and be kept in an even plane at all times.

The disk-truing device is mounted directly in the center between the two pairs of work-feeding guides and is always in place so that it can be used whenever necessary. The device consists of a 1x4-in. machine steel bar secured to brackets at each end. A sliding saddle is mounted on this bar. On one side of the saddle is secured an adjustable vertical slide. The wheel-truing cutters are mounted on a cutter spindle on the lower end of the slide. A pull-and-push rod is attached to the saddle for drawing the dresser back and forth across the face of the grinding disk.

The grinding machine used for the work carries a wheel 53 in. in diam. and 1¼ in. thick. The machine consists of a bed casting, a vertical-spindle bearing housing, an upper guard-ring support and a drive-shaft pillow block. The vertical-spindle bearing housing mounted on one end of the bed plate has a web bottom in which the lower spindle bearing is mounted. The top spindle bearing is set in a cover plate secured to the top of the housing. A machined opening is provided on one side into which the shaft-bearing unit is fitted. The guard-ring support is also mounted on the top of this housing and is of a circular sloping design. It is lower on the inside to provide an opening beneath the disk wheel for the exhaust. Piping is attached at two points on the underside and connected directly to the exhauster. An exhauster can be furnished with the machine or the shop exhauster system may be used. This can be direct-connected.



Besly Vertical Disk Grinder, Special Adaptation

The vertical spindle is 3½ in. in diam. and a wheel collar 11 in. in diam. is shrunk on the upper end and equipped with radial and self-aligning ball thrust bearings. All bearings are fitted in removable housings set in the main castings. The bevel driving gears are made from steel. They have a ratio of 2½ to 1, 4 pitch, and run in an oil bath. The horizontal drive shaft, 2½ in. in diam. runs in split, phosphor-bronze ring-oiled bearings which are dustproof.

A 15-hp. a.c. or d.c. motor can be connected to the drive shaft through a flexible coupling. The exhauster pulley is mounted on the hub of the coupling.

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Warner & Swasey Universal Tools for Turret Lathes

The equipment shown in the four accompanying illustrations has been designed by the Warner & Swasey Co., Cleveland, Ohio, for use principally in connection with the Nos. 1, 2, 4 and 6 turret lathes made by this company. The multiple turning head with an overhead pilot attachment, illustrated in Fig. 1, is particularly adapted for small and average lots of work of a medium or heavy nature, since it permits the use of heavy feeds without necessitating special pilot bars.

The head has a radial adjustment to compensate for wear without sacrificing rigidity. The bar is supported in the head by means of four screws to provide a four-point bearing for alignment with a bushing on the head of the machine. After the alignment is secured the bar can be firmly clamped by means of a washer and nut on the rear end.

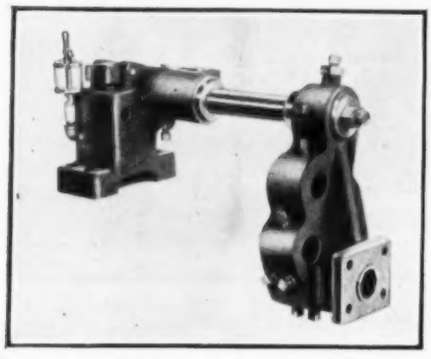


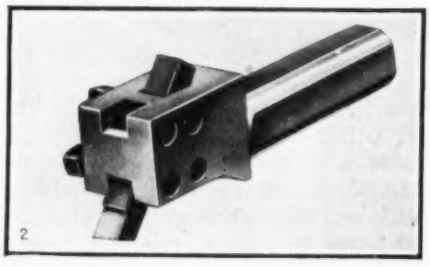
Fig. 1—Warner & Swasey Universal Turning Head with Overhead Pilot Attachment

The overhead pilot bar passes into a bracket which attaches to the front of the head of the machine. The adjustable bushing makes it possible to attach the bracket to the machine when not in use. Only one bracket and bushing are required for each machine since the pilot bar of each multiple turning head can be accommodated in the one bushing.

The multiple turning head itself contains holes located at different distances from the center to provide for an increased turning range. Various cutter holders of different styles can be used for turning, boring, facing and chamfering. Forged boring cutters may be held in the center hole by using a rocker bushing. The center hole can also be fitted with stub boring bars, drills, reamers, pilot bars and similar tools. The head is of a heavy and rigid construction and is designed to afford suitable tool clearances.

The off-set cutter holder, illustrated in Fig. 2, is designed for use in the multiple turning head when the cutter would project too far if used in the straight or angular cutter holders. Slots for the cutters are grooved from the solid, leaving tie pieces between the sides of the holder to prevent them from springing.

The holder is moved in and out of the head for the length of the cut. The cutter is held by means of two screws. The entire holder is hardened and the shank is ground and flatted. When two diameters of different sizes must be turned and bored the overhang of the cutters can be reduced with the holders by stepping them down and up.



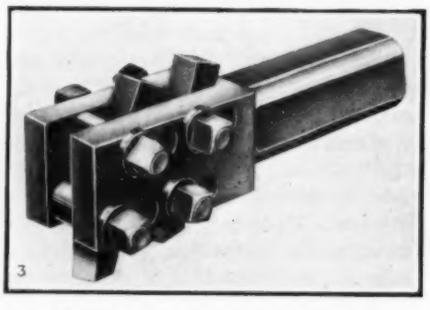


Fig. 2—Off-set cutter holder.
Fig. 3—Multiple cutter holder

The multiple cutter holder which is illustrated in Fig. 3 is similar to the holder shown in Fig. 2. It carries two cutters which are adjustable to different positions for turning two diameters at the same time, or for turning and facing. Tie screws and bushings are furnished to prevent the sides from springing apart when clamping the cutters. Holes are provided which make it possible to shift them to different positions for a number of combinations of tools. This holder, like the one described previously, can be moved in and out of the head for the length of the cut and it is hardened and has its shank ground and flatted.

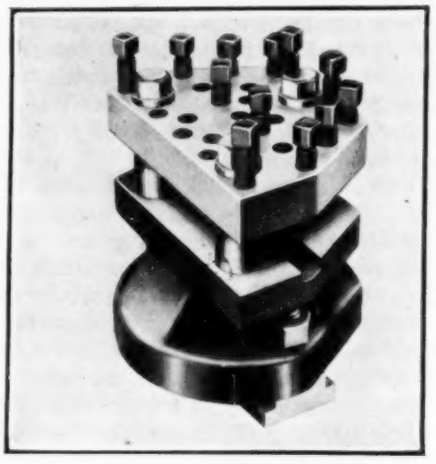


Fig. 4—Cross-slide cutter block

The universal cross-slide cutter block, shown in Fig. 4, is designed to make unnecessary special cutter blocks on multiple facing and forming operations. The blocks are available either for the front or the rear, the rear block being higher than the front one.

Each block can be swung in four different positions on the cross-slide. The cutters can be clamped in a variety of combinations in each of the four positions. Forged cutters are used so that when changing from one job to another it is necessary to regrind and reset the cutters only. The block is made of steel and is of a heavy and rigid construction.

Husky Ratchet and Hexagon Socket Wrenches

The line of wrenches manufactured by the Husky Wrench Co., 928 Sixteenth Ave., Milwaukee, Wis., has been increased, some of the additional units being shown in the illustration.

The H. D. 1, 20-in. ratchet is for heavy-duty service and has a drop-forged handle. The No. 21, speeder is 20 in. long. It has a shank 10 in.

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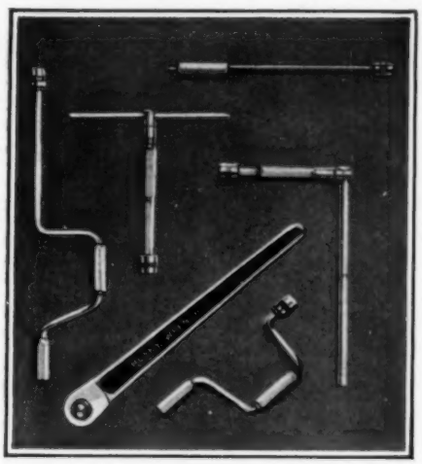
long and the end is upset, forged on and milled. The No. 17, brace is similar in design, but the shank is 2 in. long. The No. 9, 10-in. and the No. 11, 15-in. swivel extensions have solid milled ends and a hexagon swivel grip. The No. 14, 15-in. combination "T" is for the standard husky set. It provides a 15-in. leverage and has an alloy-steel, hardened head.



Husky Ratchet and Hexagon Socket Wrenches

Square sockets are made in 9 additional sizes from $\frac{3}{8}$ to 1 in. Four large hexagon sizes for industrial purposes range from $1\frac{1}{16}$ to $2\frac{3}{8}$ inches.

Several lines of the wrenches manufactured by this company have been previously described from time to time in the *American Machinist*.

Victor "Hi-Tensile" Capscrew

The Victor Peninsular Co., Detroit, Mich., is manufacturing a cold-headed capscrew from high-carbon steel heat-treated. The "Hi-Tensile" screws are made from steel having a carbon content of 0.30 to 0.37 and manganese of from 0.65 to 0.85. The steel is comparable to S.A.E. No. 1035. The steel used is inspected for chemical and physical defects.

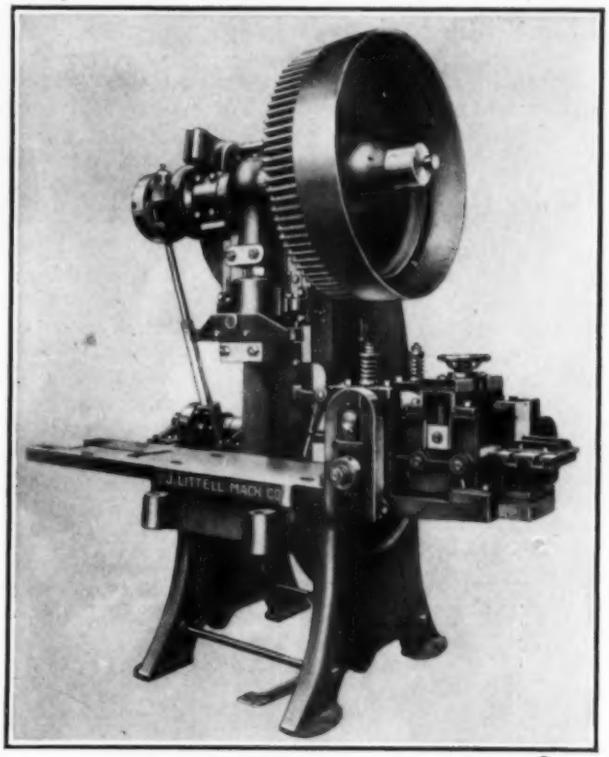
The physical properties claimed for the screws when heat-treated are a yield point of from 70,000 to 100,000 lb. per sq.in., an ultimate strength of from 95,000 to 120,000 lb. per sq.in., a minimum elongation of 15 per cent, a minimum reduction of area of 45 per cent and from 196 to 231 Brinell hardness.

Littell Heavy-Duty Automatic Roll Feed

A heavy-duty automatic roll feed has been brought out by the F. J. Littell Machine Co., 4125-4127 Ravenswood Ave., Chicago, Ill. The feed is designed to handle cold-rolled stock 0.137 in. thick and 4 in. wide, and also 14-gage stock 8 in. wide. The stock for which the feed illustrated was designed comes in rolls weighing approximately 600 lb. It passes through a power-driven, three-roll straightener and then through the feed roll.

The feeding rolls are made from tool steel, hardened and ground. The straightening rolls are also hardened and ground. They are power-driven and are connected through gearing to the feeding rolls. The feeding rolls are $6\frac{1}{2}$ in. in diam. and $8\frac{1}{2}$ in. wide. All gears are made from machine steel.

The illustration shows the attachment mounted on a press. It can feed from 0 to 11 in. at each stroke. The machine is designed to operate with an open belt, at 78 strokes per min. with a feed of about 6 in. per stroke. The photograph shows the feed mounted on a bolster plate which is arranged for a double-row feed and scrap cutter. For this reason, the single-roll feed is on the right-hand side of the machine, although the feed is from left to right ordinarily.



Littell Heavy-Duty Automatic Roll Feed

The equipment is particularly adapted for blanking heavy hardware.

"Jagabi" Stationary Tachometer, Type B

The "Jagabi" type B stationary tachometer is being manufactured by James G. Biddle, 1211-13 Arch St., Philadelphia, Pa. It operates on the centrifugal principle and will rotate in either direction. The instrument is suitable for use on all types of rotating machinery where it can be belt connected. It is particularly adapted for permanent mounting on dynamometers, steam and internal-combustion engines, generators, motors, low-speed turbines and pumps, water turbines and similar cases.

"Jagabi" Stationary Tachometer

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The instrument is operated through a ¼-in. roundbelt by means of a pulley 2 in. in diam. The pulley is mounted on a shaft having ball bearings. Oil cups are provided for the shaft and for the tachometer mechanism. The pedestal is of aluminum.

The No. 100 instrument for feeds of between 600 and 2,400 r.p.m., is illustrated. There are seven sizes in the line for ranges of from 150 to 8,000 revolutions per minute.

Gibbs Disk-Drive Drilling Machine

The drill press illustrated is being manufactured by the Gibbs General Machine Co., 830 West Broadway, Louisville, Ky., to provide a tool having no belts or gears. The principle of transmission in this press is the V-disk, the material of which is either specially treated fiber, common red fiber or hard fiber.

The transmission consists of a spindle cone, a drive cone, low- and

Gibbs Disk-Drive Drilling Machine

high-speed motor spurs and a speed-change disk having an indicator attached. To change the speed the indicating speed-shift dial is drawn out to the limit of its travel and turned until the desired speed is indicated. To change from low series to high series, the motor is pulled out of contact with the drive cone and the cam on which the motor pivot bracket rests, is reversed. The angularity of the grooves and the disks is 18 degrees.

The entire spindle head can be raised by loosening the clamps at the top of the column and turning the crank handle provided, after the gear shift lever shown near it has been set in the proper position. When the lever is down, the turning of the handle operates the vertical traverse of the table.

The spindle cone is fitted with double-row, deep-groove ball bearings. Means are provided for the lubrication of the motor, spindle and cone bearings. The bearing of the fiber transmitter is supplied with plumbago and requires no oil when the machine is used principally for low speeds. A special bearing is provided where the high speeds predominate.

Eighteen speeds, nine in low series and nine in high series are provided. The range of speeds is from 125 to 5,250 r.p.m. The capacity of the machine is for ¾-in. drills, and in brass for 1-in. drills. The table movement can be 25 in. and the maximum distance from the chuck to the table is 39 in. S.K.F. ball bearings are used throughout on the machine. The motor used as standard is a General Electric ¼-hp., single-phase. A V-block and table center are furnished with each machine.

Bonney Chrome-Vanadium Wrenches

The double open-end wrenches illustrated in Fig. 1 and the socket wrenches shown in Fig. 2 are made from chrome-vanadium steel by the

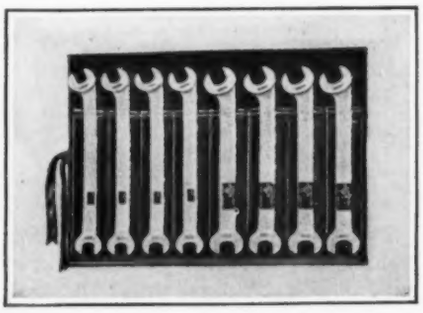

Fig. 1—Bonney Chrome-Vanadium Open-End Wrenches

Bonney Forge & Tool Works, Allentown, Pa. By the use of this material and special heat-treatment, the company has aimed for refinement in design, particularly as to the thickness of the side walls, so that the wrenches will be more adaptable.

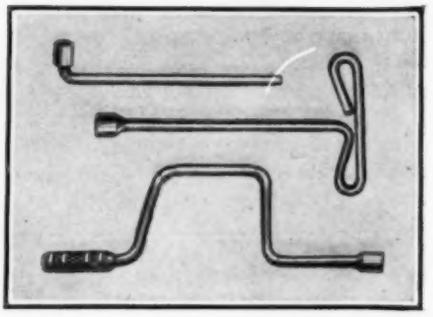

Fig. 2—Chrome-vanadium socket wrenches

The socket wrenches shown in Fig. 2 are made in three styles: The offset type, the T-handle type and the brace type which is made in 20- and 30-in. sizes. They are of one-piece construction. A ball bearing handle is provided for the brace-type wrenches.

"Grand Rapids" Universal Cutter and Tool Grinder Motor-Driven, No. 1

The Gallmeyer & Livingston Co., 346 Straight Ave., S. W., Grand Rapids, Mich., has redesigned its No. 1 "Grand Rapids" cutter and tool grinder, illustrated, to provide for a self-contained motor drive. The machine is similar in general principles of construction to the No. 2 universal cutter, tool and drill grinder previously described on page 1065, Vol. 63 of the *American Machinist*, the principal difference being that the latter is designed with an attachment for grinding drills.

The grinding wheels are driven from a ¾-hp. motor mounted in the base of the machine. A swing door makes the motor easily accessible when it is necessary to make bearing adjustments or to clean the commutator. A snap switch is provided on the side of the base. The base carries also a column on which is mounted the grinding head which carries two wheels. The column is hollow and the belt for driving the wheels passes through it to the motor. The table is moved up and down on the column by means of a handwheel operating a vertical screw through bevel gears. The table can be clamped in position on the column.

A 1/12-hp. lamp-socket motor is built into the headstock to provide

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"Grand Rapids" Universal Cutter and Tool Grinder, Motor Driven, No. 1

for handling internal and cylindrical work. For internal grinding, the table can be swung on the column and clamped at right angles to the grinding head. The work-spindle is driven through a worm to provide the necessary slow speed of rotation.

The machine will swing work between the centers 9½ in. in diam. and 20 in. long. The longitudinal movement of traverse is 1 in. and the transverse movement is 7 in. The table can be raised over a distance of 6¾ in. on the column. The capacity for face-milling cutters is 12 in. in diam. The weight of the machine is 585 pounds.

General Electric Synchronous Motors

The General Electric Co., Schenectady, N. Y., has designed and is now marketing a line of synchronous motors for general purpose work. Those motors are intended to drive any load whose torque requirements have been heretofore met with a standard squirrel-cage induction motor. The new motors are of the G.E. types TS and QS, and are known as the 7500 series.

The motors meet all the Electric Power Club requirements for a general purpose motor. The ratings range from 20 to 150 hp., with speeds of 1,200, 900, 720, and 600 r.p.m. at 60 cycles. The motors are rated at 40 deg. continuous.

"Whitcomb-Damerell" Combination Shaper and Milling Machine

The Reed-Prentice Co., Worcester, Mass., has placed on the market the "Whitcomb-Damerell" combination shaper and milling machine equipped with an attachment suitable for milling the clearance for the cutting tool when the shaper is being used to replane the pockets for uprights on steam and drop hammer bases. A view of the whole machine is shown in Fig. 1 while in Fig. 2 is illustrated the attachment.

The motor used on the attachment is a standard 1½-hp. electric drill operating at 180 r.p.m. The construction is said to be sufficiently rigid so that a cut ⅛ in. deep can be taken.

The machine on which the milling attachment is used, is a portable draw-cut shaper intended for planing ram and sow blocks, new seats for hammer uprights and for squaring the base of hammers, or for machining other large castings. They are built in two sizes to handle surfaces 48 and 66 in. square.

The bridge is of heavy angle cross-section, ribbed at short intervals. It is supported at each end by means of a saddle scraped to rails. The bridge is operated through long screws controlled by a crank handle at one end of the rail. The bridge may be brought to any position desired. Both rails are connected by a cross-rod. The cross-rod, which can be seen at the right in Fig. 1, has been provided with means for adjustment.

The rails are clamped to the base by means of dogs of a special design. They have hardened edges and are constructed so as to adapt themselves to irregular surfaces. Provision is made so that the rails can be adjusted parallel to each other after the clamping dogs have been set.

The power is derived from either a 3-hp., 1,800-r.p.m. a.c. motor, or a 3-hp. 1,700-r.p.m., d.c. motor. The machines weigh 2,600 and 3,077 lb. respectively, without the attachment.

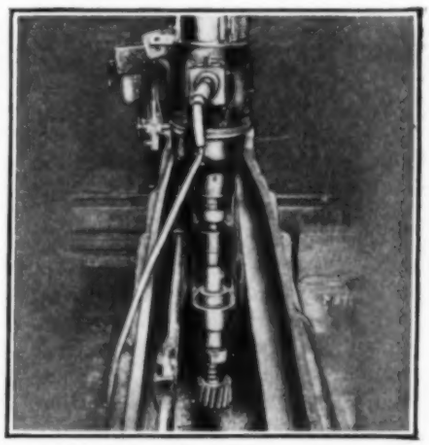

Fig. 2—View of the milling attachment

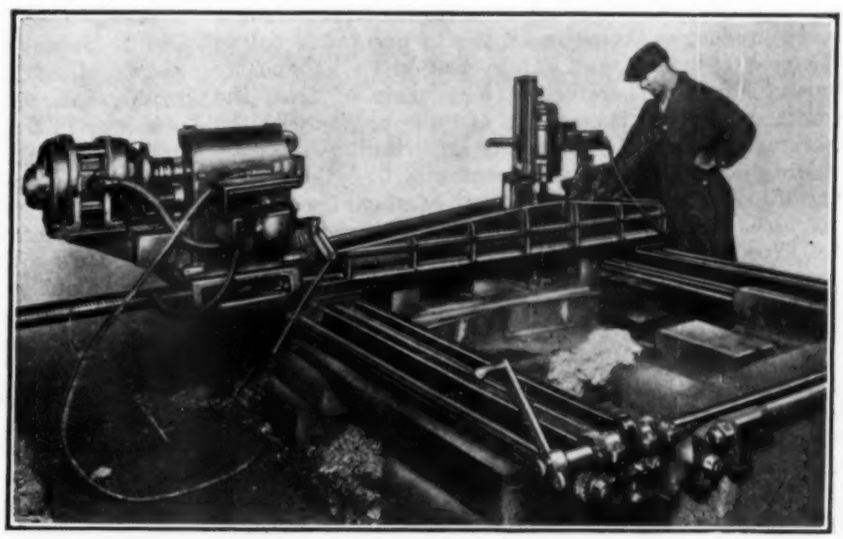

Fig. 1—"Whitcomb-Damerell" Combination Shaper and Milling Machine

Is Engineering Education Too Technical?—Discussion

By Donald A. Hampson

Your editorial, "Is Engineering Education Too Technical?" which appeared on page 1060 of the *American Machinist* of Dec. 31, 1925, Vol. 63, No. 27, deserves serious consideration. The answer to that query must stand unreservedly upon the showing that the men who have received such training make in the world of engineering.

Some years ago an apprentice asked his shop foreman what kind of a shop it was to learn the trade in, and the latter replied that it depended entirely upon the kind of machinists it turned out. The shop was new and small then, and even today there are only fifty men in it, but more than a score of apprentices have been trained there and have left to go into other lines from die sinking to railroad work. From the reports that have been received it is known that every one of those boys made good from the start. The training that they received must have had something to do with it, that is certain.

The engineer and his training must be measured by the same yardstick. "What can you do?" and "How well can you do it?" are the two things that the world wants to know and, of necessity, they include the commercial end. If his designs, his orders, or his ideas do not permit the work to be done profitably or to compete with the commercial products of the day on an equal footing, he cannot be called successful no matter how correct his ideas may be from a technical standpoint.

The engineer must know something of the "buy and sell" in his particular world; he must comprehend the outline of financial practice; he must keep ever before him the human side. Not one of these things could be called "technical" by any stretch of the imagination and they would be scorned as selectives in outlining the subjects of a technical education. Of these three, the greatest is the human side.

Must Have Practical Knowledge

The greatest lack of the college trained man chiefly is along the practical side of things. Every design, every product and every plan has to be worked out in the cold elements that nature has given us and by human hands. Therefore, a long training from the workman's ground is essential, and a sympathy with the workman's conditions is equally important.

More technical men fail from this lack than from any other. Back of the long lists of alumni who have "resigned from the X plant and taken a position with the Y people" lies an equally long list of employers who have paid said engineers a good salary for a couple of years, hoping to at least get their money back, but who have found that they would not fit into their organizations because they were so technical that they scorned to be practical. Where industry is dependent upon labor of the independent type, which we have developed here in America, those who plan and direct must have their feet on the ground with labor.

It is a recognized fact that technical students would be better prepared to fill positions successfully and that they would get far more out of their college training if they had a few years of practical experience before entering college. Record show that the men who have had to work for some years before entering college (perhaps saving the money to go) get along a great deal faster and comprehend more than the boys who have never been under authority but rather have been and expect to be the pampered sons of fortune.

About two years ago, one of England's foremost mechanical engineers in addressing his class at the beginning of a new term said to them, "I cannot prevent any of you from taking this course, but I do hope that none of you has had less than two or three years' machine shop experience. I might add that by another year I expect that one of the University's requirements for admission to this course will be that very experience." The writer does not know whether this is now an accomplished fact but trusts that it is so.

It goes to prove that on the other side, where they are at least as thorough as we are, they are ready to take the bull by the horns and demand that practical experience (and the workman's viewpoint) take its place as one of the foundation stones for a technical training, along with mathematics. Two months endured in a shop in the summer does not even savor of experience.

The case of Sheldon might serve as a typical example. He took the position of designer and production man in a growing plant in the automotive parts line. He had had ten years of experience with New England concerns in kindred work. The concern paid him double what they had ever paid anyone else, based upon the positions he had "held" and his technical training; heretofore they had only their own trained men as executives, none of whom possessed more than correspondence school education.

He Was Too Technical

Sheldon had some good ideas and he knew his chemistry and his statics. He had made a splendid record at Tech and it was very evident that his was an engineering mind. But he openly avowed that there was no society there for himself and his wife and that everything was very raw. His world ended with the New York State line.

He designed some machines that should have been great reducers of cost and that would have been, if he had the workman's interests at heart. But he had a theory that "labor gets off pretty easy nowadays" and he arranged everything possible so that the men had to stand at their work, when they could have as readily sat. Then, in instructing them on new processes or in the operation of new machines, he showed little sympathy or co-operation. This general attitude toward the workers prevailed throughout his régime which, it may be imagined, was marked by an entire absence of enthusiasm on the part of the men.

Sheldon's drawings looked like line engravings and his technique was perfect, even though his work was not successful commercially or practically. If he had spent a few years himself "pulling levers" or had known how much conservation of energy is appreciated by the humblest of workers, then his work would have been an outstanding success financially, and his crew would have praised him among their fellow workers. As it was, all hands were glad to see him go, while the management is through with technically trained men forever.

Engineering education, therefore, is not too technical, but it is decidedly too non-practical except for the research man or the consultant.

News of the Week

Research Committee Reports Completion of Gear Testing Machine for A.S.M.E.

Chairman Lewis announces beginning of tests at M. I. T.

The construction and testing of the gear testing machine demonstrated at the last annual meeting of the American Society of Mechanical Engineers has been completed, and the special research committee on gears, appointed by the society to supervise this work, has just reported the results of the final tests. The report, submitted by the chairman, Wilfred Lewis, states that after the demonstration at the meeting, the machine was returned to the manufacturer for further attention before being shipped as intended to the Massachusetts Institute of Technology for the series of investigations under the direction of Prof. Edward F. Miller.

A countershaft with change pulleys was placed directly over the pinion shaft and arranged to be driven by a 5-hp. variable speed reversing motor, so that eventually the pinion shaft can be driven at any speed from 75 to 3,000 r.p.m. to give from 1,000 to 6,000 ft. per min. on the gear teeth in action.

The perfection of the recording mechanism has been a matter of careful study and attention. Lateral freedom in the main fulcrum plate was suggested by Mr. Fleisher to prevent cramping, and this is accomplished by clamping this plate after all other clamps have been set.

A New Compensator

As pointed out by Professors Fuller and Haven, before the designs for the gear tester were accepted by the M. I. T., there was much room for improvement by reducing the weight of the moving parts in the recording mechanism and in devising some way to "float" the stylus, so that it might not tend to return to a central position when displaced. Accordingly a compensator was devised and attached, and this gave pretty good results. More travel, however, was found to be necessary to register the errors in commercial gears when multiplied some 250 times, so it was increased to 1½ in., and again to 2 in., when it was seen that the "compensator" had lost a good deal of its original efficiency.

An analysis of the compensator was then made, showing that while its efficiency was originally 93 per cent for 1 in. travel it was only 64 per cent for 2 in. travel, and a new adaptation of the same principle was made. Here the link between the radius arm and the multiplying lever is extended to form a lever to which a tension spring is attached, and a pivot is substituted for the fulcrum plate previously used. This was completed and assembled on the machine. The mechanism "floated" better than it ever did before and showed very good results in diagrams made by hand, without power, under a light initial load.

Soon after the installation of the machine at Cambridge it was found that the outer gear shaft bearing needed a better support on the swing frame and this was provided, care being taken to secure an accurate alignment of the three telescope bearings by balancing the overhanging weight and turning the telescope by hand. This bearing may now be clamped to the outer pinion shaft bearing, or it may be secured to the swing frame independently. But, after making this improvement, great difficulty was encountered in ascertaining the initial load on the test gears. Sometimes it appeared to be considerably more and at others much less than was expected from the position of the torsion nut, and investigation showed an unexpected increase in the friction of the Bakelite insulating bearings. These had been very carefully fitted to slide by hand without shake, but the friction was found to have increased from a few pounds, perhaps 10, to about 1,200 lb. and the tightening of these bearings was probably due to their absorption of moisture after the heavy spring storms, which for a time flooded the laboratory. Accordingly the test gear shaft was removed and a carefully turned piece of wood coated with fine sand was used as a lap to restore the original fit. Since then there has been no trouble from this cause, no shake has developed in these bearings and readings consistent with the position of the torsion nut have always been obtained. Volt meters were introduced in the circuit through the telephone receivers and by means of a clamp attached to the test pinion very accurate measurements of the initial load on the teeth are obtainable.

Solid Steel Pulleys

It was realized, however, that speeds above 1,200 r.p.m. should not be undertaken with the split pulleys on the pinion shaft, and accordingly solid steel pulleys have been provided for the higher speeds.

The timing device, which was applied originally to the delineation of sine curves, from which to determine the mass effect at pitch line of various combinations of gears and flywheels has given excellent results, but it was not quite an instrument of precision because the mechanism which carried the paper ribbon was subject to appreciable changes in speed, depending upon the tension in its main spring. Nor was the old speedometer used in New York a satisfactory measure of speed, and while looking for something better, the committee was referred to Philadelphia as having a constant speed motor which might be adapted to his purpose. A little Emerson motor guaranteed to run with slight variation in voltage was obtained and was attached to the timing device very successfully, converting it into a first-class instrument of precision. Then it occurred to the chairman that the same paper ribbon might be utilized as a recording tachometer and by means of a few home-made links and levers this has been done at very small expense.

Engineering Foundation Elects Stillwell

Lewis B. Stillwell, of the American Institute of Electrical Engineers and also of the American Society of Civil Engineers, was elected chairman of Engineering Foundation at the annual meeting of that body on Feb. 11. Elmer A. Sperry, of the A. S. M. E., and George A. Orrok, of the American Institute of Mining and Metallurgical Engineers, were elected vice-chairmen. Two additional members of the executive committee were selected as follows: J. V. Davies and Arthur M. Greene, Jr. Other officers of the organization are: Alfred D. Flinn, director and secretary; Jacob S. Langthorn, treasurer; and Henry A. Larnder, assistant treasurer.

Patents Granted to Americans in Britain

Inventions by women figure prominently in the applications filed at the British Patent Office, according to consular advices to the Department of Commerce. It is estimated that in 1925 applications filed by inventors of both sexes totalled 35,000 for the year. Of this number approximately 12,000 relate to motor vehicles and internal combustion engines.

While many women remain faithful to inventions for the improvement of domestic articles, large numbers are entering other fields of research, and have patented wireless and mechanical devices.

At least one-quarter of the applications filed have come from the United States and Germany. The German inventions relate mainly to dyes, wireless, electrical systems, and scientific instruments; American inventions mostly concern motor vehicles, electrical and labor-saving devices and machinery.

The Market for Industrial Machinery in Canada Needs Attention from American Manufacturers

Statistics show dominion was our best customer last year

The question of representation and allocation of sales territories in Canada is a most important one to the American manufacturer of industrial machinery, especially in view of the fact that Canada has long held its position as the largest market for American machinery. Only in 1921 did Canada relinquish first place to Mexico, running a close second, however, with imports of $28,474,868 as against $30,784,076 for Mexico. Canada became again our best industrial machinery customer in 1922 and has held this position ever since.

It appears probable, from the accompanying statistics for the eleven months (January to November, inclusive) of 1925, that Canada has retained its leading position as a market for American machinery through the past year. The second most important foreign market for United States machinery, the United Kingdom, is also the only important competitor of the United States, outside of Canada herself, for the Canadian machinery trade. The British trade, though small in comparison with that of the United States, has been gradually increasing and emphasizes the importance of intelligent sales methods on the part of American manufacturers.

A few agressive firms in Canada representing American manufacturers of industrial machinery are covering the entire Dominion on an exclusive agency basis. The head offices of these concerns are in Montreal or Toronto, and they have branches at strategic points from the Atlantic to the Pacific. As a general proposition, representation by such a firm is likely to produce the most satisfactory results.

It appears, however, that practically all of the limited number of machinery agents having an adequate selling organization to cover the whole country are now carrying just about as many lines as they can capably handle. The only alternative of the American manufacturer seeking an agent is, then, to make suitable connections with energetic distributors in Montreal for eastern Canada; in Toronto for Ontario and the Prairie Provinces; and possibly in Vancouver for British Columbia. A considerable number of American manufacturers of industrial equipment have divided the territory of their agents in Montreal and in Toronto by a line connecting the towns of Pembroke and Kingston, Ontario, the Montreal firm soliciting business East of this line and the Toronto firm covering the field West of these points. There is some difference of opinion as to the precise location of this dividing line, but the city of Ottawa is logically located in the Montreal territory.

It is desired to place particular emphasis upon the danger of passive rather than active consideration of Canadian business by American manufacturers. The proximity of the market does not mean that American firms can leave everything to their agents in the Dominion. As a matter of fact, with keen and increasing competition from both Canadian and European machinery manufacturers, the sales of American equipment can be maintained only by especially close co-operation in marketing.

A representative should be stationed in Canada by the American manufacturer, if the volume of business warrants the expense, acting as liaison officer between the factory and the Canadian sales agent. A less expensive step would be the assignment of a factory representative to visit the Dominion annually. In Canada, as in all other countries, self-starting, continuously active agents are the exception rather than the rule.

The allocation of sales territories in Canada is an individual, not a general problem. In the case of machinery the decision as to adequate representation depends upon the kind of equipment which the manufacturer wishes to sell and upon the location of the principal Canadian users of such equipment.

A matter of the utmost significance in the sale of American industrial machinery in Canada is the increasing investment of American capital in the industrial development of the Dominion. The outstanding current projects, other than hydro-electric, are new pulp and paper mills, mining enterprises, and the large aluminum plant on the Saguenay River. In all of these enterprises American capital is very prominent, and in many instances the machinery orders are being placed in the United States.

Citroen Expands Plants Outside of France

Citroen, French automobile builder, has organized assembly plants at Stowe, near Windsor, England, and Milan, Italy, the former with an ultimate production schedule of 100 cars daily and the latter 40 cars daily, according to the Department of Commerce.

Both plants will be in operation by April, it is said, although their maximum production will not likely be attained for some time. Similar plants are also being planned for Belgium and Spain. The majority of the car parts will be shipped from Paris to these plants and assembled there, but a certain proportion will be manufactured in the local assembly plants.

The Citroen company has decided to abandon the 5 hp. model entirely, and will concentrate on the 10 hp. The production schedule for the former which during 1925 ran even with the 10-hp., is being steadily curtailed, and by April the smaller type will be eliminated entirely. The Paris plant is now producing about 240 cars a day, according to M. Citroen, and after April this figure will represent only the 10-hp. type. The change in policy was made to secure greater efficiency through a single model. On the basis of 240 cars of the single model per day, 100 will have open bodies, 100 will be sedans, 25 will be for taxicabs, and 15 will be special jobs.

It is estimated that during 1925 the Citroen company built upwards of 70,000 cars, and was thus the leading European producer. Between 30 and 40 per cent of this number, it is said, were exported.

To Expand Value of Census Statistics

Before any effort is made to induce Congress to authorize a census of distribution, which would require a large appropriation, it is proposed to select two or three important lines for the purpose of giving the plan a trial.

The first opportunity for the experiment will be when the manufacturers census is taken in 1928. If the trial demonstrates the value of this expansion of the census statistics, the appeal then can be made to Congress for the full census of distribution, or the work can be undertaken gradually.

This plan will require legislation, but no large amount of money.

France and Italy Buy German Machinery

German manufacturers of agricultural machinery recently held the first fair of a proposed series at Lille, France, under the protection of the North France Agricultural Association, states a report to the Department of Commerce. The fair was well attended and it is reported that orders for 60,000,000 francs worth of German machinery were placed during the first two weeks of the fair.

These sales of German machinery were in effect payments in kind to the French farmers for their claims against the French government for damage sustained during the war and the French government credits the amounts of these purchases against reparation payments from Germany. No serious objection has been made to this procedure by French manufacturers of implements due, no doubt, to the activity that has prevailed in that industry during the past year. Eleven additional fairs are scheduled in the series and the next is to be held at Laon.

Germany is supplying an increasing portion of the Italian imports of agricultural machinery and during the first half of last year 52 per cent of the implements imported into Italy originated in Germany. Those shipments amounted to 4,348 metric tons and this percentage shows an increase over the same half of 1924 when Germany's share of Italian importations was 43 per cent.

Railway and Automotive Shops Furnish Most British Machinery Business

Exports and imports show decline in value per ton

BY OUR LONDON CORRESPONDENT

The position of the British machine tool and machinery industry is still without any new features, but it can be suggested that no real decline is evident and that those firms which a month or two ago were busy remain in that condition, while most of the others are probably no worse off than they were. Thus, while some firms have a fair amount of work in hand, others depend for their activities on orders received from week to week.

The two forms of traction, motor vehicles, pleasure and commercial, and steam locomotion, continue to provide the bulk of the orders, though the complaint is heard that the home railways are not ordering; yet it must be claimed that there are exceptions. For some time the locomotive shops of the railway companies have been installing new tools, and superintendents have been asking for authority to obtain further supplies in this line.

Railway shops have, in fact, helped in the somewhat increased demand from overseas for British machine tools. South Africa, Australia and the Argentine have been mentioned as profitable markets within recent date, while work is expected in connection with New Zealand. After a quiet period, India has again been ordering. Grinding machinery, in particular for railway work abroad, has found considerable application, and some attention has been paid also to the gear-grinding problem, though British machines for this purpose are not yet available. Apart from machines for use by one firm specializing in the actual work of gear-grinding, the machines are not being marketed.

Outside the railways, carriage and wagon works have not called for many tools recently. Several makers of power presses of various kinds have lately successfully tendered for supplies overseas. Work in this line and, in fact, throughout the whole of the machine tool industry, is somewhat irregularly distributed.

Orders for locomotives have been given by the railway companies to their own and outside works, and in shipbuilding the receipt of some few orders for vessels has brightened the outlook.

To judge by the special returns obtained from the British Board of Trade by the European edition of *American Machinist*, machine tools of the lathe class are still the backbone of exports of this kind, forming more than one-third of the total value and weight of machine tool exports. Lathes were also the most prominent class in imports of machine tools, but forming less than one-fifth of the total value and very nearly a quarter of the total weight. Similarly they are the most prominent item in the re-exports, that is the exports of machine tools of foreign manufacture that are routed through England.

Leaving out parts, exports totalled 14,256 tons, the value being £1,547,153, averaging about £108 per ton, while imports amounted to 4,896 tons valued at £729,032, with an average of about £150 per ton. The re-exports totalled 381 tons, valued at £45,457, averaging £119 per ton. The three divisions, exports, imports and re-exports, all show a decline in value per ton. But it will be seen that on the ton basis imports are still about 40 per cent higher in value than exports, which at least shows that the imported tool does not compete merely on account of price. The only class of lower ton-value in imports than in exports is the milling machine, which averages £111 per ton as against £123 for the British-made machine.

While a decline in total values is shown in re-exports, the exports and imports show increases, each of about £200,000 in value during the year, and imports, it will be seen, were about half the value of the exports. Proportionately their increase has been greater, as outside the war period the ratio would probably be nearer one-third.

During the same period Great Britain exported about £622,559 worth of engineers' tools, including milling cutters, stocks and dies, drills, wrenches, spanners, etc., but not gages. The corresponding imports totalled £577,041, and re-exports £54,415.

Would Make Screw Thread Commission Permanent

Under the terms of a bill introduced by Representative Tilson, and which has been approved by the Committee on Coinage, Weights and Measures, the National Screw Thread Commission is given a permanent status.

When the commission was created, July 18, 1918, its term was for one year. The intention at that time was to work out standards for only a few of the more commonly used threads. The work done by the commisison on those threads indicated a need for its extension to other threads and tolerances. This led to several extensions of the term of the commission.

The demand for the continuance of the work is greater today, it was pointed out, than at any other time. While the more generally used threads have been standardized, there still is much work to do along other important lines.

The continuance of the commission was urged by the Secretary of Commerce and the Director of the Bureau of Standards.

The new bill makes no change in the character of the commission. It is to continue to be composed of the Director of the Bureau of Standards, who is to be the chairman; two representatives of the Army, to be appointed by the Secrtary of War; two representatives of the Navy, to be appointed by the Secretary of the Navy; and four to be named by the Secretary of Commerce, two of whom are to be chosen from nominations made by the American Society of Mechanical Engineers and two from nominations made by the Society of Automotive Engineers.

Steam Versus Oil-Electric

Some interesting results of a test recently completed by the Central Railroad of New Jersey, on the efficiency of an oil-electric locomotive, have just been announced. This particular type of locomotive was placed in operation in the New York terminal of the company and an accurate record of its performances was made.

The locomotive operated for 24 days with a total of 347 working hours. It handled a total of 61,556 tons at a total fuel cost of $72.58. A steam locomotive, operating under almost identical conditions in 24 days rendered 297 hours service, and during this time moved a tonnage of 50,493 at a cost for fuel and oil of $349.46.

The cost of fuel per 1,000 tons handled was $1.16 for the oil-electric as compared with $6.92 for the steam locomotive.

Packard to Build Own Proving Ground

The Packard Motor Car Co. has purchased more than five-hundred acres of land for an automobile proving ground. The tract which lies two miles south of Milford, Mich., is one of the few spots in southern Michigan which is hilly in character. There is, however, a large flat expanse on which it is planned to build a two-mile speedway.

Engineers are at work laying out a number of tracks besides the two-mile course. Some of them will have steep grades so that cars can be given every kind of road experience. Actual work on the new testing plant will be started as soon as the frost leaves the ground in the spring. The speedway, which is to be only one-half mile shorter than the Indianapolis motor race course, will have all turns so banked that cars of the fastest type can be driven with wide-open throttle.

Hills steeper than those found on any motor highway in the country will make possible severe hill climbing tests and any danger lying in high-speed testing on the public highways will be removed.

Packard already has its own airplane landing field adjacent to Detroit.

Bulletin No. 393, entitled "Trade Agreements, 1923 and 1924," has been issued recently by the Bureau of Labor Statistics of the U. S. Department of Labor. This is the first bulletin issued by the bureau that is devoted entirely to agreements between employers and employees, though copies of many labor agreements have appeared in various bulletins and in the *Labor Review*.

The Business Barometer

This week's outlook in Commerce, Finance, Agriculture and Industry based on current developments

By Theodore H. Price
Editor, *Commerce and Finance, New York*

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THE pulse of business seems to be beating a little less rapidly. The slowing down, which is almost imperceptible, is probably due to the changed trend of the New York stock market.

There are many who seem unable to understand why an easier stock market should have any effect upon the distribution of merchandise, and for their information it may be explained that when a man who owns a hundred shares of stock sees it quoted at a 10 per cent advance he is more disposed to buy something he thinks he requires than when a stock he owns has declined 10 per cent. If he doesn't sell his stock and its intrinsic value remains unchanged his real worth is unaffected by any change in the market value of his shares, but he is more likely to be economical when the stock market is declining than when it is advancing.

The *New York Times* of Feb. 13 published a dispatch from Florida headed "Lull in Florida Disturbs Buyers," and it is confirmed by private advices that indicate a growing eagerness to sell and a decided disinclination to buy Florida real estate at present prices. Here again it should be pointed out that there has been no destruction of wealth in Florida, and that the community collectively considered is as well off as it ever was. But the speculative enthusiasm has subsided, with the result that the disposition to spend lavishly has been checked.

Of the stock market, considered apart from the general situation, it can only be said that the upward movement seems to have culminated two weeks ago when the total of brokers' loans was published and the government undertook to enjoin the bread baking trust and the huge consolidation of food stores that were in process of formation.

But other consolidations have been since announced. One of them is a combination of flour mills in the West. Another is a consolidation of cinder block manufacturers. A third includes the sardine packers of Maine, and still another is a merger of some important knitting mills in New York state.

These combinations have attracted some attention in Washington, and certain Congressmen have also been fulminating over the big New York bank merger announced last week. But it is not expected that the government will initiate any further suits until those lately brought have been decided. Meantime a rumor that some other prominent New York banks would be consolidated has been vigorously denied by the institutions mentioned.

The bond market is, if anything, a shade easier, and the sale of $75,000,000 New York City bonds on a basis of 4.185 per cent indicates that the interest rate on securities of this character is about 14 points higher than it was a year ago, when New York City was able to sell another large issue on a basis which returned but 4.045 per cent. The difference is not important, but it has been construed as indicative of a distinct trend in the market for long-time securities.

A slight recession in distributive trade throughout the country is indicated by a reduction of about 1½ per cent in freight car loadings for the week ended Feb. 6, but bank clearings still run ahead of last year, and the decrease in car loadings should not be taken too seriously.

Wheat, upon the whole has been droopy, and corn still reflects the liquidation of the supply held in the smaller elevators. The dullness of the cotton market continues to be its oustanding feature, but exports have been relatively small and the statistical situation is superficially bearish.

Sugar has had a slight recession, but it recovered toward the end of the week on reports of heavy purchases in Cuba for Far Eastern account.

Rubber is slightly easier. Mr. Hoover has published some figures which indicate that an astonishingly large amount of rubber has been reclaimed by melting down worn out tires and other used rubber material.

The money market is practically unchanged, and the weekly statement of the Federal Reserve System is without any special significance.

Viewed synthetically, the business situation may be said to be satisfactory, but not exciting, and there is nothing to indicate any noteworthy contraction or expansion in the near future. On Friday French francs fell to 3.56½ cents on reports that the French cabinet had been forced to resign. This report lacks confirmation, but it is evident that no acceptable solution has as yet been found for the financial problems by which France is confronted.

International financiers are somewhat amused by the announcement that the coffee stabilization bonds sold in London by the State of Sao Paulo are now being marketed in New York at an advance on the London price. These are the bonds whose issue in the United States was blocked by our government upon the theory that their proceeds would be used to maintain the price of Brazilian coffee of which America consumed the lion's share. The incident is only another proof that capital, like water, flows in the direction of least resistance. An analogous situation is to be found in the protest that Lancashire is making against the action of the Egyptian government in an attempt to stabilize the price of Egyptian cotton.

Upon the whole the foreign outlook is tranquil and the trend is toward increased efficiency and activity except in France, where the financial predicament of the government will continue to be an irritant until the budget is balanced by the imposition of taxes that will provide the necessary revenue.

What's Doing in Industry

It would not be correct to say that machinery business had slowed up in the past week or ten days. It is true that orders have been fewer, and for smaller amounts; but general activity—which includes inquiries and making quotations—has increased. Business has assumed a steady trend, and the outlook for spring is brighter now than it was a month ago.

Cincinnati reports a slight increase in sales, railroads and general manufactures taking up orders. Automotive and parts manufacturers are buying in Milwaukee and employment has increased in large plants. Detroit sales are lagging, but new inquiries by motor car manufacturers afford plenty of prospects for future business.

Both Cleveland and Indianapolis report a lull for the present, with prospects for better business as soon as present inquiries can be answered.

The Canadian market is quite active, expansions in railway and paper making projects affording good business. New York is marking time, waiting for early spring business to materialize. In Buffalo there has been an increase in sales, many small orders giving a satisfactory total.

The general business situation may be said to be satisfactory, but not exciting and there is nothing to indicate any noteworthy contraction or expansion in the near future.

The Industrial Review

Progress of the machinery and machine-tool business in various parts of the country

THE following reports, gathered from the various machinery and machine tool centers of the country, indicate the trend of business in these industries and what may be expected from the future:

Milwaukee

Moderate activity pervades the machine tool market. Conditions generally are described as favorable, in expressions of manufacturers of metal-working equipment. The current month's progress has been satisfactory, and the outlook for March trade is regarded as promising.

Manufacturers of passenger cars, motor trucks and tractors in this locality are buying tools in a fair way, with one or two other interests placing some sizable requirements. The same is true of makers of automotive units, parts and accessories, which are now beginning to feel the first effect of a heavy increase in requirements from automobile factories in other centers. Farm implement makers are making excellent progress and much is expected of this industry as a buyer of metal-working equipment.

Railroad business continues to be disappointing. Extensive re-tooling of a large local ship is still in abeyance, due to financial circumstances.

Cleveland

A slight decrease in sales of machinery and machine tools for the past two weeks was noticed in this district. A majority of firms interviewed report business as being only fair. One or two exceptions were noted, however, these firms reporting receipt of several large orders. The total volume of sales for February is expected to be slightly less than January.

Development of the local market as a buying center is seen in the announcement of a prominent local contractor that the estimated amount of new industrial construction work will go over the $10,000,000 mark for 1926. Among a few of the new factory buildings now under construction and planned at the present time are: Cleveland Automobile Co., W. S. Tyler Co., Lindsay Wire Weaving Co., Aluminum Company of America and the Morgan Brass Co. New machinery will be required for all of these projects.

Canada

The most significant feature of the machine tool business in Canada at present is that the railroads are showing signs of being in the market for more material than they have purchased for several years.

The buying movement has already started in real earnest. The Canadian National Railways have placed the following orders: One elliptic spring forming machine, one tube sheet drilling machine, four motor-driven floor grinders, one air motor hoist, three tire retaining ring fixing machines, four belt-driven air compressors, one 4,000-lb. steam hammer, and one 400-ton double-end wheel press.

The Canadian Pacific Ry. has placed an order with the National Steel Car Corporation, of Hamilton, Ontario, for 53 passenger coaches and 315 refrigerator cars. The Hamilton corporation has also received an order from the Temiskaming & Northern Ontario Ry. for a number of passenger coaches and baggage cars. The Canadian Pacific Ry. has also ordered from the Eastern Car Co., 235 steel underframes, and from the Canadian Car and Foundry Co., 375 coal cars and 50 refrigerator cars.

Announcement is made by the Canadian Locomotive Co. that it has secured the right from the Colorado Iron and Fuel Co. to manufacture the American company's line of mining machinery.

For its new mill at West Templeton, Ontario, the International Paper Co. has ordered from the Dominion Engineering Co., four newsprint paper machines, which are believed to be the largest in the world.

Detroit

Most dealers in machinery and machine tools in Detroit agree that there is at present a lull in the market, but there the agreement ends. There are some who point out that as a rule after the first of the year business declines, only to make rapid forward strides with the coming of spring. But on the other hand there are some who believe that the lull may preface a season of heavy buying.

One encouraging sign on the horizon at present is the increased activity of the Ford Motor Co. January was dull, but this month has found several extensive lists put into the hands of dealers.

The Chrysler Motor Corporation is buying more equipment than for some time. Part of this, however, is second-hand. One firm recently placed eight second-hand drilling machines in the Chrysler plant. Six of a similar type were placed in the Reo plant at Lansing.

Several building programs, including those at the Dodge and Hudson plants are almost completed, and while most of the heavy machinery has already been ordered for these new additions, some equipment yet remains to be purchased.

Employment in Detroit and throughout the state continues at a high peak, the Detroit figures showing within two or three thousand of the high peak of all time.

Indianapolis

A further slight increase in machine tool and machinery sales is noticed in this territory. Dealers say the increase has not been marked, when it comes to actually getting names on the dotted line, but a large volume of five prospects and a large number of inquiries has appeared. Grinding machines and punch presses have been doing well in the local market. Continued expansion in the automobile factories here has resulted in these factories becoming good buyers of tools.

Railroads are making inquiries, apparently getting ready for spring work, but thus far actual buying is restricted.

Cincinnati

In the past week the market trend has continued upward. Some manufacturers report greater increases in sales than others, but all regard the improvement as good enough to be a basis for encouragement.

On the other hand there is a small minority of manufacturers who report that the past week was a "bald spot" from a sales standpoint. All of these, however, regard the falling off in orders as merely transitory.

Railroad purchases were confined to replacements, but a large number of inquiries are reported to have come in from this source in the past few days. Orders and inquiries from the textile industry are reported to have increased in number, and the automotive industries bought more freely and sent more inquiries than in the previous week.

The greater portion of the orders booked came from the general field, by which is meant concerns in the metal trades, general machinists, industrial machine tool users, etc. Practically all of this buying was of replacements.

The week's business was well spread out over the country and well diversified as to the types and sizes of tools desired. Inquiries coming in are regarded as showing conclusively that a large number of tools are needed in all sections of the country.

New York

No improvement of a substantial nature is evident in this market. The second half of February has brought a slowing up of orders, but on the other hand has brought more inquiries than have been issued in several months.

Orders for single high production machines are being placed regularly, but there have been few orders calling for long lists. Railroads and manufacturers of railway equipment have been active in taking up machinery, and manufacturers of electrical apparatus and hardware are also in the market.

Some of the equipment orders last week included: One combination journal turning and axle lathe, two 30-in. cylinder grinders, three hand milling machines, two spline milling machines, eight rotary surface grinders, one 14-in. vertical grinding machine, two automatic milling machines and a 26-in. x 8-ft. planer.

Buffalo

Business among the machinery and equipment dealers continues on a par with the report of two weeks ago. In some quarters there is the complaint that the first two weeks of February were not as brisk as the first two weeks, or even the last two weeks, of January.

The demand for contractor's equipment is down but this is considered seasonable and no one is alarmed about it. The sale of snow removal and similar equipment continues to be good..

The demand for electrical equipment keeps pace with that of machinery. Orders are comparatively small but the total bulks large.

One large order received here called for eight special ball grinding machines for an Eastern steel company.

New England

Machinery builders having orders from companies in the automotive industry, and contracting machinists with outputs for that trade, are unanimous in denying rumors current that cancellations of orders are being received. During the past week such reports have been circulated, but are without foundation. The condition is quite the reverse—more orders being in prospect. February business is better than January business, so far as relates to the automobile industry.

Railroad buying was excellent during the past week. Substantial orders for shop equipment were received.

Manufacturers of machinery for the textile trade report a fair volume of replacement buying.

Manufacturers of chucks and dies find de-

mand improving, although much of the buying is still of the "hand to mouth" variety. Export business is of good volume.

Chicago

No new features of special significance have developed in the machine tool market within the last week. Orders are being closed by larger dealers, but the average of sales is estimated as being about the same as has prevailed since the first of February.

Inquiries continue satisfactory. The C. R. I. & P. Railroad is in the market with another list of tools for shop equipment, and the Santa Fe is out with an additional list. Inquiries for tools and special machinery from the Western Electric Co., the Nash Motors Co., the Beaver Manufacturing Co., the Grover Co., Hotchkiss Blue & Co., Paul M. Mathey, and Robert J. Rote are among those received during last week, their requirements covering a variety of tools and machines.

What the Railroads Are Doing

"Nothing has happened to indicate recession in business," says C. H. Markham, president of the Illinois Central R.R. "Freight traffic on our road is running ahead of last year and I believe this will continue for another three months at least. Though our car loadings in January showed a decline as compared with last year, both gross revenue and net railway operating income was larger than in 1925. Indications are that February earnings will show similar increase over last year. We expect to place orders soon for 2,300 freight cars."

The Island Creek Coal Co. has sold the Island Creek R.R. Co., a ten-mile railroad at Logan, W. Va., to the Chesapeake & Ohio Ry. Co. for $1,500,000. The road has been operated by the Chesapeake & Ohio for twelve years under lease.

The Island Creek road runs south from Logan and constitutes the only connection between the Chesapeake's Logan & Southern R.R. and the main line into Logan County. The road was built in 1902 and placed in operation in 1904.

The Northern Pacific Ry. is inquiring for one thousand 50-foot automobile cars to cost about $2,600,000. This is one of the largest equipment inquiries announced in some time by any railroad in the Northwest.

L. R. Caperon, freight traffic manager, states that the Northern Pacific is looking forward to larger shipments of automobiles in the Northwest this year.

The Canadian Pacific has ordered 235 steel underframes from the Eastern Car Co.; 315 refrigerator cars, 42 steel car frames and 11 baggage cars from the National Steel Car Corporation; and 375 coal cars, 74 steel frames and 50 refrigerators cars from the Canadian Car and Foundry Co.

The Minneapolis, St. Paul & Sault Ste Marie has ordered 100 general service cars from the Pullman Car and Manufacturing and the Southern has placed orders for repairs to 500 gondolas with the Mount Vernon Car and Manufacturing Co.

The Southern Pacific is in the market for 23 locomotives and the New York Central is asking bids on 500 box cars.

The Rock Island & Pacific budget for 1926 provides for the purchase of 10 Mikado freight locomotives, five passenger locomotives and five baggage cars. Besides various extensions and train control installations, the company expects to lay during year 45,000 tons of new rail and extend its yard tracks and sidings at 46 points on the system.

The Rock Island has ordered 28,000 tons of rails from the Illinois Steel Co., and 5,000 tons from the Inland Steel. The St. Louis Southwestern has placed orders for 10,000 tons with the Illinois Steel, and 3,200 tons with Bethlehem. The Missouri-Kansas-Texas has purchased 13,000 tons, mostly from the Tennessee Coal, Iron and Railroad Co. and the Minneapolis & St. Louis, 5,000 tons from Chicago makers.

New inquiries in the market include twenty Mikado and twenty-four Pacific type locomotives for the Canadian Pacific; 2,250 freight cars for the Southern Railway and 1,000 for the Northern Pacific.

News of the Automotive Industry

Announcement has been made at the Stutz factory in Indianapolis that all production schedules would be doubled and as soon as men can be employed the company expects to work three eight-hour shifts.

Export business of the Paige-Detroit Motor Car Co. in 1925, showed an increase of 100 per cent over the preceding year, exclusive of Canadian business. The greatest gain was in Europe and South Africa, both of which took three times as many cars as in 1924. The best individual European customer was Germany where importation for cars from foreign countries had been restricted previously by government regulations that were virtually prohibitive. Demand in Germany is now for the highest priced models in each of the various classes. In quantity, Australia was the best market, according to the Paige report. Present year will see further gains, according to H. M. Jewett, president, who says that the company's production plans are based on an export business for 1926 that will be more than twice that of last year.

The Chevrolet plant at Flint has attained a new high record in output. On a daily schedule of 19 hours, the motor division is turning out 135 Chevrolet engines an hour, or 2,565 a day, which is approximately one-half of the current production rate at the Ford Motor Co.

A year ago, Chevrolet was turning out less than 1,500 motors a day. Production schedule for March has been set at 57,000 jobs which will compare with a probable total of 51,000 for February.

Production at the Dodge Bros. plant is being advanced steadily to new high records to meet orders received from both United States and foreign dealers. From between 1,000 and 1,100 cars a day, the January average, output went over 1,200 February 4, passed 1,350 on February 8 and exceeded 1,400 on February 10.

The Moon Motor Co. has announced plans to retail a light six-cylinder car at slightly less than $1,000. The company looks for a total production of 25,000 Moon and Diana cars, an increase of about 41 per cent over 1925. Preliminary figures indicated a turnover of ten times in 1925. Earnings were estimated at $1,200,000.

Personals

A. L. GARFORD has retired as president of the Cleveland Automatic Machine Co., of Cleveland.

A. R. PINNEY has joined the sales force of the Bonney Forge and Tool Works, Allentown, Pa.

SIR MAX MUSPRATT has been elected president of the Federation of British Industries.

FRED. H. MCISAAC has been elected president of the Kirk-Latty Manufacturing Co., of Cleveland. He succeeds the late Samuel D. Latty.

B. ABBOTT has been appointed sales manager of Nuckey, Scott & Co., Compton Ave., London, England, tap and die manufacturers.

W. S. ROE is now in charge of the machine tool department of Armstrong, Whitworth & Co., Ltd., Openshaw, Manchester, England.

H. W. RUPPLE has been elected a director of the Cleveland Automatic Machine Co., succeeding Richard Le Blond, who recently resigned.

HUBERT D. BENNET has been elected president of the Toledo Scale Co., and O. C. Reeves has been appointed general factory manager.

S. T. JOHNSTON, of the S. Obermayer Co., Chicago, has been elected president of the Foundry Equipment Manufacturers' Association.

G. M. WILLIAMS, president of Nordyke & Marmon Co., of Indianapolis, has been named chairman of the manufacturers' committee of the Indianapolis Chamber of Commerce.

WILLIAM H. SMITH of the engineering staff of the Ford Motor Co., has resigned and will hereafter conduct an engineering consulting business under his own name.

J. M. IRELAND has been appointed Cleveland Sales Manager of the Westinghouse Electric and Manufacturing Co. He was formerly manager of the industrial department in the Cleveland district.

The Wayne Tractor and Equipment Co. has been incorporated at Ft. Wayne, Ind., to deal in machinery and farm implements. The incorporators are Alfred L. Randall, J. H. Payne and John Wilding.

L. R. WILSON, managing director and vice-president of the Abitibi Power and Paper Co., Iroquois Falls, Ontario, has been elected president of the Canadian Pulp and Paper Association.

SIR HOLBERRY MENSFORTH has been appointed managing director of Bolckow, Vaughan & Co., Ltd., Middlesbrough, England, ironmasters, and is vacating the position of Director-General of Factories in the British War Office.

F. A. FENTON formerly attached to the New York sales office of Joseph T. Ryerson & Son, Inc., has opened offices at 30 Church St., in New York, and will act as representative of machinery manufacturers.

JAMES G. ELLIS, of St. Lambert, Ontario, foreman patternmaker at the Canadian National Ry. shops, Point St. Charles, has retired after half a century of service with that railway.

R. A. AUSTIN has succeeded J. P. Doolan as superintendent of the maintenance department of the Morgan Engineering Co., of Alliance, Ohio. Mr. Doolan has been placed in charge of special engineering work for the company.

THOMAS J. LITTLE, JR., has resigned as chief engineer of the Lincoln Division of the Ford Motor Co. He is now located at 733 Seyburn Ave., Detroit, where he will establish a business as engineer and production expert.

HERMAN STEINKRAUS has been appointed manager of the sales and service branch in Cleveland for the Bridgeport Brass Co., of Bridgeport, Conn. Mr. Steinkraus was formerly associated with the Cleveland Automatic Machine Co., and with the Osborn Manufacturing Co.

F. J. JORDAN, mechanical engineer, has joined the staff of Robert C. Sweatt, Ltd., dealer in heavy machinery, Vancouver, B. C. Mr. Jordan, who has had wide experience in the design, sale and construction of power plant machinery and equipment, takes the position of chief engineer of the company.

GEORGE O. DESAUTELS, authority on drop forging equipment, left Indianapolis recently for a ten weeks' tour of France, England, Italy, Switzerland, Belgium and Germany. Mr. Desautels is head of the steel manufacturing company which bears his name and is making the trip in the interest of four large manufacturing companies he will represent in Indianapolis.

Obituaries

T. W. WARD, founder of the well-known Sheffield firm of T. W. Ward, Ltd., England, died on Feb. 3. He was 73 years old.

LUTHER HESS, owner of the Hulley Machine Foundry plant at Marion, Ind., died recently of heart disease. He was 61 years old.

LIEUTENANT JOHN A. TOBIN, U.S.N., retired, inventor of the metal known as Tobin bronze, died recently. He was 74 years old.

EDWARD B. PIKE, president of the Pike Manufacturing Co., manufacturer of grinding wheels, died at his home in Pike, N. H., on Feb. 17. He was 60 years old.

SAMUEL R. MYERS, superintendent of E. C. Atkins & Co., saw manufacturers of Indianapolis, for twenty-eight years, died recently at his home following a brief illness. He was 71 years old.

Business Items

The American Iron and Metal Co. has opened an office at 238 West Pearl St., Indianapolis.

The Lake County Screw and Bolt Co., at Gary, Ind., has filed a certificate of final dissolution.

The May Brass and Foundry Co., of Chicago, will move its plant to Ladoga, Ind., as soon as it is possible to complete arrangements.

Joseph T. Ryerson & Son, Inc., announce the removal of their New York sales offices from the twentieth to the nineteenth floor of the building at 30 Church St.

The Postalwait Machine Co. has opened a plant at 1841 Ludlow Ave., Indianapolis.

Shepherd & James have opened a machine shop plant at 21 North Alabama St., Indianapolis.

The firm of Joseph Rhodes & Sons, Ltd., Wakefield, England, manufacturer of machine tools for sheet-metal work recently celebrated the centenary of its business, the firm having, in fact, been founded in 1824.

The Velie Motor Co., of Marion, Ind., will move its motor plant and equipment to Moline, Ill. The move will be gradual in order to prevent any break in production. Superintendent Lunde of the machine department is in charge of dismantling the Marion plant.

The Reading Chain and Block Corporation, of Reading, Pa., manufacturer of electric hoisting machinery, has established offices at 327 First Ave., in that city. L. W. Lutz has been appointed manager.

Manning, Maxwell & Moore, Inc., of New York, have acquired the patents and good will of the Beaman & Smith Co., of Providence, R. I., manufacturer of special boring and milling machines. These machines will now be manufactured at the Putnam Machine Works, Fitchburg, Mass.

The Aeromarine Plane and Motor Co. and Healey & Co., both of Keyport, N. J., have combined their manufacturing interests under the firm name the Healey-Aeromarine Bus Co., Inc. The consolidated plant will manufacture auto buses, airplane apparatus and motor accesories.

The Bearings Co. of America has been purchased by a group of manufacturers in Philadelphia and headquarters for a new organization will be located in the Bullitt Bldg., in Philadelphia. F. H. Germane, of the Timken Roller Bearing Co., is president of the reorganized firm.

Announcement is made by the Brooks Steam Motors, Ltd., which has been manufacturing motor cars at Stratford, Ontario, that the company will concentrate on the development of a 32-passenger business bus, and on trucks. The manufacture of motor cars will be continued, however, and production will be increased.

The Anderson Engine and Foundry Co., Anderson, Ind., a new corporation that succeeded the Anderson Foundry and Machine Co., which failed along with other industries in the R. L. Dollings Co., is making progress, it was shown at the annual meeting of the stockholders recently. E. W. Cooney, president and general manager, and all other officers were re-elected.

The Standard Forgings Corporation, of Delaware, has been organized. The firm was formed from the merger of the Pollak Steel Co. (South Chicago plant), the Standard Forgings Co., of Chicago, and the St. Louis Forgings Co., of East St. Louis, Ill. George E. Van Hagen is president of the new corporation. The various plants of the companies will be engaged in the manufacture of car axles and forgings for railroads, car builders and automobile and tractor manufacturers.

The National Electric Manufacturing Co., of Pittsburgh, has appointed the following sales agents: The Electric Sales Co., Canton, Ohio; Arthur E. Jones Co., Syracuse, N. Y.; Imperial Machinery Co., Wheeling, W. Va.; Roberts Electric Co., Sherman, Texas; J. M. Wheeler, Harrisburg, Pa.; J. W. Bartholow Co., Dallas, Texas; Van-Bernard-Neville Co., Kansas City, Mo.; Fort Wayne Pipe and Supply Co., Fort Wayne, Ind.; Home Equipment Co., Nashville, Ten.

The Allis-Chalmers Manufacturing Co., of Milwaukee, announces that its business in Continental Europe will be handled through an organization recently incorporated as Allis-Chalmers (France), with headquarters at 3 rue Taitbout, Paris. H. I. Keen, who has been manager of European sales through the company's district office in Paris, will be the managing director of the new organization. The company has maintained for many years an office in London, at 728 Salisbury House, London Wall, E. C. 2.

In the organization of the board of directors of the Monarch Machine Tool Co., Frank P. Thedieck was elected president to succeed his father, the late I. H. Thedieck who had served as president since the organization of the company more than 18 years ago. W. H. Wagner was re-elected to the office of vice-president, and W. E. Whipp was named secretary, treasurer and general manager. Directors chosen include F. P. Thedieck, W. H. Wagner, A. C. Getz, W. E. Whipp, E. J. Griffis, L. M. Studevant, E. E. Kah, Val Lee and Philip Wagner.

The Adams E.D.T. Inc., is the name of a new organization in South Bend, Ind., which will specialize in the manufacture of dies and tools. The company is equipped to design and manufacture special and automatic machinery and do general machine work. It is headed by C. R. Adams, president and general manager. Other officers are Delos M. Coen, vice-president, and L. M. Adams, secretary and treasurer. Mr. Adams severed his connections as engineer and superintendent of the Sibley Machine Co., which position he held for ten years. Prior to that time he was assistant engineer of the Chandler Motor Car Co.; production engineer of the F. I. A. T. Motor Co.; general foreman of the Goodman Manufacturing Co., general foreman of the Pierce-Arrow Motor Co., and tool designer of the St. Louis Car Co.

Trade Catalogs

Ball Bearings. The Bearings Co. of America, Lancaster, Pa., has issued a 25-page, 4¼x7¼-in. catalog of thrust and angular-contact ball bearings and ball retainers. The catalog consists of specification sheets of the different sizes of each model. Views of the parts as well as a specification drawings are included.

Electric Furnaces. Automatic Electric Furnaces, Ltd., Elecfurn Works, 173-175 Farrington Road, London, E. C. 1, England. Several photographs of the Wild-Barfield electric furnaces on exhibition at the British Industries Fair, Birmingham, Eng., are contained in a circular being distributed by this company. Short descriptions of each set of equipment illustrated, are given.

Machinery. Louis E. Emerman & Co., 1761 Elston Ave., Chicago, Ill. The No. 26 Emerman Red Book of machinery, tools and supplies has been published by this company. All machinery listed is arranged according to classifications in alphabetical order. Short descriptions, specifications, the price and frequently illustrations are given. A wide range of miscellaneous equipment and supplies is contained in the back of the catalog.

Tool Steel. Henry Disston & Sons, Inc., Philadelphia, Pa. A tool steel catalog has been issued by this company, descriptive of the various types of electric-furnace tool and alloy steels included in the Disston line. Among those listed are high-speed, non-shrinking, fast-finishing, hot and cold-die, trimmer-die, alloy-chisel, and standard steel compositions. The catalog contains much valuable information on the uses, methods of heat-treatment and physical characteristics of the steels, and it is supplemented with useful tables of standard steel data. The booklet, which has forty-eight, 5½x8-in. pages, is artistically prepared. The design of the pages is attractive throughout.

Wrenches. Bonney Forge & Tool Works, Allentown, Pa. Catalog No. 26 has been prepared in a miniature edition for the sake of convenience. The bulletin contains forty 3½x5-in. pages and it lists the specifications of the various sizes in which each of the models in the line manufactured by this company may be had. Illustrations of each design are shown. Various other items of shop and garage equipment are listed and illustrated in the back of the book.

Turret Lathes. Jones & Lamson Machine Co., Springfield, Vermont. A twenty-four page, 6x9-in. booklet has been prepared on chucking problem No. 3, one of a series entitled "The Problems of Your Shop." Many illustrations are given and the text is full and well organized.

Calendar of Local Meetings

National Association of Cost Accountants

Boston. Feb. 25. "Some Debatable Points in Cost Accounting," by Clinton H. Scovell.

Detroit, Feb. 25. "Computing and Distributing Power Costs."

American Society for Steel Treating

Hartford. June. Spring sectional meeting.

American Society of Mechanical Engineers

Newark, N. J. March 3. "Economic Aspects of Buying and Replacing Machine Tool Equipment."

New York. March 4. Engineering Societies' Building. "Water Purification for Textile Processes."

Society of Automotive Engineers

Detroit Section. Feb. 25. "Airplane Engine Maintenance," by Lieut. Cyrus Bettis.

Forthcoming Meetings

American Management Association. Annual convention, Hotel Astor, New York City, March 3, 4 and 5. Headquarters, 20 Vesey St., New York City.

National Railway Appliance Association. Annual meeting and exhibition, Coliseum and Annex, Chicago, March 8 to 11th. C. W. Kelley, secretary, 845 So. Wabash Ave., Chicago.

National Metal Trades Association. Twenty-eighth annual convention, Hotel Astor, New York, April 15 and 16. Secretary, J. E. Nyhan, Peoples Gas Bldg., Chicago, Ill.

National Foreign Trade Council. Thirteenth national foreign trade convention, Charleston, S. C., April 28, 29 and 30. O. K. Davis, secretary, India House, Hanover Square, New York.

American Gear Manufacturers' Association. Tenth annual meeting, Book-Cadillac Hotel, Detroit, May 13, 14 and 15. T. W. Owen, secretary, 2443 Prospect Ave., Cleveland, Ohio.

American Supply and Machinery Manufacturers' Association. Annual convention, Hotel Statler, St. Louis, week of May 17. F. D. Mitchell, secretary, 1819 Broadway, New York.

National Association of Purchasing Agents. Eleventh annual convention and exposition, Ambassador Hotel and Auditorium, Los Angeles, Calif., June 9 to 12. W. L. Chandler, secretary, Woolworth Bldg., New York.

Society of Industrial Engineers. Thirteenth national convention, Bellevue-Stratford Hotel, Philadelphia, June 16, 17 and 18. Executive secretary, George C. Dent, 608 S. Dearborn St., Chicago.

American Society for Testing Materials. Twenty-ninth annual meeting, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., June 21 to 25. C. L. Warwick, secretary, 1315 Spruce St., Philadelphia.

The Weekly Price Guide

Rise and Fall of the Market

Iron and Steel—Iron quotations remain firm despite slowness of current buying. Outlook for steel demand is best in direction of pipe, fabricated structurals, tin plates, strip steel and sheets, other than black and blue annealed. For three successive weeks, prices on the principal hot-rolled steel products have been as follows: bars, $2; shapes, $1.90 @$2; plates, $1.80@$1.90 per 100 lb., Pittsburgh mill. Compared with prices of a year ago, bars show no change; shafting is down; and bolts, washers, etc., are slightly higher.

Non-Ferrous Materials—Declines in Connellsville coke are very marked since ending of coal strike. Compared with prices effective at this time last year, cotton waste shows no change; abrasives and lubricants are higher; fabricated brass, solder, lard cutting oil, and belting are down.

(All prices as of Feb. 19)

IRON AND STEEL

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	
No. 2 Southern	$24.05
Northern Basic	24.27
Southern Ohio No. 2	24.27
NEW YORK—Tidewater Delivery	
Southern No. 2 (silicon 2.25@2.75)	28.37
BIRMINGHAM	
No. 2 Foundry	22.00@23.00
PHILADELPHIA	
Eastern Pa., No. 2x (silicon 2.25@2.75)	24.16
Virginia No. 2	29.17
Basic	23.16
CHICAGO	
No. 2 Foundry local	23.00
No. 2 Foundry, Southern (silicon 2.25@2.75)	26.55
PITTSBURGH, including freight charge ($1.76) from Valley	
No. 2 Foundry	22.27
Basic	22.27
Bessemer	22.27

IRON MACHINERY CASTINGS—Cost in cents per lb. of 100 flywheels, 6-in. face x 24-in. dia., hub not cored, good quality gray iron, weight 275 lb.:

Detroit	5.00@5.50
Cleveland	5.00@5.25
Cincinnati	5.00@5.50
New York	5.25@5.50
Chicago	5.25@5.75

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the mill base in large lots.

Blue Annealed	Pittsburgh Mill Base	New York	Cleveland	Chicago
No. 10	2.40@2.50	3.89	3.25	3.50
No. 12	2.45@2.55	3.94	3.30	3.55
No. 14	2.50@2.60	3.99	3.35	3.60
No. 16	2.60@2.70	4.09	3.45	3.70
Black				
Nos. 18 to 20	3.05@3.15	4.30	3.90	3.90
Nos. 22 to 24	3.10@3.20	4.35	3.95	3.95
Nos. 26 and 27	3.15@3.25	4.40	4.00	4.00
No. 28	3.25@3.35	4.50	4.10	4.10
Galvanized				
No. 10	3.50@3.60	4.50	4.25	4.25
Nos. 12 to 14	3.60@3.70	4.60	4.35	4.35
No. 16	3.75@3.85	4.75	4.50	4.50
Nos. 18 to 20	3.90@4.00	4.90	4.65	4.65
Nos. 22 to 24	4.05@4.15	5.05	4.85	4.80
Nos. 26 and 27	4.20@4.30	5.20	5.10	4.95
No. 28	4.50@4.60	5.50	5.25	5.25

WELDED STEEL PIPE—Warehouse discounts are as follows:

	New York Black	New York Galv.	Cleveland Black	Cleveland Galv.	Chicago Black	Chicago Galv.
1 to 3 in. steel butt welded	53%	39%	55½%	43½%	54%	41%
2½ to 6 in. steel lap welded	48%	35%	53½%	40½%	51%	38%

Malleable fittings: Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36-5% off.

Size, Inches	List Price per Foot	Diameters Inches External	Diameters Inches Internal	Thickness Inches
1	$0.17	1.315	1.049	.133
1¼	.23	1.66	1.38	.14
1½	.27½	1.9	1.61	.145
2	.37	2.375	2.067	.154
2½	.58½	2.875	2.469	.203
3	.76½	3.5	3.068	.216
3½	.92	4.0	3.548	.226
4	1.09	4.5	4.026	.237
4½	1.27	5.0	4.506	.247
5	1.48	5.563	5.047	.258
6	1.92	6.625	6.065	.28

SEAMLESS STEEL TUBING—Following net prices are for seamless mechanical tubing, cold drawn, round, .10 to .30 carbon, at warehouse in lots of less than 100 ft.:

Thickness B.W.G. and Decimal	Fractions	Outside Diameter in Inches ⅛	¼	⅜	½	⅝	1	1⅛	1¼
		Price per Foot							
.035″	20	$0.15	$0.16	$0.17	$0.18	$0.19	$0.21	$0.23	
.049″	18	.17	.18	.19	.20	.21	.23	.25	
.065″	16	.19	.20	.21	.22	.23	.25	.27	
.083″	14	.20	.22	.23	.24	.25	.27	.29	
.095″	13	.21	.23	.25	.26	.27	.29	.31	
.109″	12	.22	.24	.26	.27	.28	.30	.32	
.120″ or .125″	11	.23	.25	.27	.28	.29	.31	.33	
.134″	10	.24	.26	.28	.29	.30	.32	.34	

MISCELLANEOUS—Warehouse prices in cents per pound in 100-lb. lots:

	New York	Cleveland	Chicago
Spring steel (light) (base)*	7.00	6.00@7.50	4.65†
Spring steel (heavier)	4.00	....	4.00
Coppered Bessemer rods (base)	6.05	6.00	6.20
Hoop steel	4.49	3.85	4.15
Cold rolled strip steel	6.25	6.35	6.80
Floor plates	5.55	5.60	5.50
Cold drawn shafting or screw	4.00	3.90	3.60
Cold drawn flats, squares	4.50	4.40	4.10
Structural shapes (base)	3.34	3.20	3.10
Soft steel bars (base)	3.24	3.10	3.00
Soft steel bar shapes (base)	3.24	3.11	3.10
Soft steel bands (base)	3.99	3.20	3.65
Tank plates (base)	3.34	3.40	3.10
Bar iron (3.00 at mill)	3.24	3.21	3.00
Drill rod (from list)	50@60%	55%	60%

Electric welding wire, New York, 3/32, 8.25c.; 1/8, 7.85c.; 5/32 to 1/4, 7.35c. per lb. *Flat, 3/16@1/8-in. thick. †F.o.b. cars.

METALS

Current Prices in Cents Per Pound

Copper, electrolytic (up to carlots), New York			15.12½
Tin, 5-ton lots, New York			66.25
Lead (up to carlots) E. St. Louis	9.15	New York	10.00
Zinc (up to carlots) E. St. Louis	7.50	New York	8.75

	New York	Cleveland	Chicago
Antimony (Chinese), ton spot	23.25	24.50	26.00
Copper sheets, base	22.75	22.75	22.50
Copper wire, base	19.62½	16.50	16.25@16.50
Copper bars, base	22.37½	22.37½	22.12½
Copper tubing, base	24.50	24.50	24.50
Brass sheets, base	19.12½	19.12½	19.12½
Brass tubing, base	23.75	23.75	23.75
Brass rods, base	16.87½	16.87½	16.87½
Brass wire, base	19.62½	19.62½	19.62½

Shop Materials and Supplies

METALS—Continued

	New York	Cleveland	Chicago
Aluminium ingots, 98 to 99%, 1 to 15 ton lots	27.00	27.00	27.02
Zinc sheets (casks)	12.00	12.60@12.95	12.27
Solder (½ and ½), (case lots)	39.25	41.00	38@42
Babbitt metal, delivered, New York, cents per lb.:			
Genuine, highest grade			78.00
Commercial genuine, intermediate grade			56.00
Anti-friction metal, general service			31.50
No. 4 babbitt (f.o.b.)			14.50
Nickel, f.o.b. refinery, cents per lb.:			
Ingots 31.00 Electrolytic 38.00 Shot			32.00

SPECIAL NICKEL AND ALLOYS—Price in cents per lb., f.o.b. Huntington, W. Va.:

Hot rolled nickel sheet (base)	52.00
Cold rolled nickel sheet (base)	60.00
Hot rolled rods, Grade "A" (base)	50.00
Cold drawn rods, Grade "A" (base)	58.00
Manganese nickel hot rolled rods "E"—low manganese (base)	54.00
Manganese nickel hot rolled rods "D"—high manganese (base)	57.00

Base price of Monel metal in cents per lb., f.o.b. Huntington, W. Va.:

Shot	32.00	Hot rolled rods (base)	40.00
Blocks	32.00	Cold drawn rods (base)	48.00
Ingots	38.00	Hot rolled sheets (base)	42.00
Cold rolled sheets (base)			50.00

OLD METALS—Dealers' purchasing prices in cents per pound:

	New York	Cleveland	Chicago
Crucible heavy copper	12.25@12.50	11.25	11.50@12.00
Copper, heavy, and wire	12.75@12.00	11.50	11.00@11.50
Copper, light, and bottoms	10.00@10.37½	9.50	10.00@10.50
Heavy lead	8.00@8.37½	7.50	7.75@8.25
Tea lead	5.50@6.00	5.00	6.75@7.25
Brass, heavy, yellow	7.50@8.00	7.25	7.75@8.25
Brass, heavy, red	9.50@10.00	9.50	8.75@9.25
Brass, light	6.25@6.50	6.00	7.25@7.75
No. 1 yellow rod turnings	8.50@8.75	8.00	7.75@8.25
Zinc	4.75@5.25	4.75	4.75@5.25

TIN PLATES—American Charcoal—Bright—Per box

		New York	Cleveland	Chicago
"AAA" Grade:				
IC,	14x20	$11.25	$11.45	$11.50
"A" Grade:				
IC,	14x20	8.85	9.40	9.50
Coke Plates—Primes—Per box				
100-lb.,	14x20	6.45	6.10	7.00
Terne Plates—Small lots, 8-lb. Coating—Per box				
IC,	14x20	7.85	6.95	7.50

MISCELLANEOUS

	New York	Cleveland	Chicago
Cotton waste, white, per lb.	$0.15@0.22	$0.19	$0.20
Cotton waste, colored, per lb.	.10@.15½	.10	.17
Wiping cloths, washed white, per lb	.18	36.00 per M	.16
Sal soda, per 100 lb. keg	2.25	2.25	2.75*
Roll sulphur, per 100 lb. keg	3.75	3.35	5.00
Linseed oil, per gal., 5 bbl. lots	.87½	1.02	.88
Lard cutting oil, 25% lard, per gal.	.55	.50	.56
Machine lubricant, medium-bodied (50 gal. wooden bbl.), per gal.	.35	.35	29
Belting—Present discounts from list in fair quantities (½ doz. rolls).			
Leather—List price, 24c. per lin. ft. per inch of width for single ply.			
Medium grade	40–5%	40–5%	40–5%
Heavy grade	30–10%	30–10%	30–10%
Rubber transmission, 6-in., 6 ply, $1.83 per lin. ft.			
First grade	50%	50–10%	50%
Second grade	50–10%	60–5%	50–10%

*In 175 lb. kegs.

Comparative Warehouse Prices

New York	Unit	Current Price	Four Weeks Ago	One Year Ago
Soft steel bars	per lb.	$0.0324	$0.0324	$0.0324
Cold drawn shafting	per lb.	.04	.04	.0415
Brass rods	per lb	.1687½	.1687½	.1762½
Solder (½ and ½)	per lb.	.3925	.4025	.42
Cotton waste	per lb.	.15@.22	.15@.22	15@22
Washers, cast iron (½ in.)	per 100 lb.	7.00	7.00	6.50
Emery, disks, cloth, No. 1, 6 in. dia.	per 100	3.55	3.55	3.38
Lard cutting oil	per gal.	.55	.55	.60
Machine oil	per gal.	.35	.35	.29
Belting, leather, medium	off list	40–5%	40–5%	40–2½%
Machine bolts up to 1x30 in.	off list	40%	40%	45%

MISCELLANEOUS—Continued

	New York	Cleveland	Chicago
Abrasive materials—In sheets 9x11 in., No. 1 grade, per ream of 480 sheets:			
Flint paper	$5.56	$5.84	$5.65
Emery paper	10.71	11.00	10.71
Emery cloth	29.48	31.12	29.48
Emery disks, 6 in. dia., No. 1 grade, per 100:			
Paper	1.49	1.45	1.49
Cloth	3.55	3.55	3.20
Fire clay, per 100 lb. bag		.60	.75
Coke, prompt furnace, Connellsville	per net ton		4.50@5.50
Coke, prompt foundry, Connellsville	per net ton		6.00@7.00
White lead, dry or in oil	100 lb. kegs	New York, 15.25	
Red lead, dry	100 lb. kegs	New York, 15.25	
Red lead, in oil	100 lb. kegs	New York, 16.75	

SHOP SUPPLIES

Machine bolts, ¼x1½-in., per 100, $1.70. Discount at New York warehouses on all sizes up to 1x30-in., 40%; 1½ and 1¼x3-in. up to 12-in., 15%; with cold punched hex. nuts up to 1-in. dia. (plus std. extra of 10%) 30%; with hot pressed hex. nuts up to 1x30-in. (plus std. extra of 10%) 35%.

Carriage bolts, ¼x1½-in., per 100, $1.00. Discount on all sizes up to 1x30-in., 30%.

Coach and lag screws, ½x$\frac{5}{16}$in., $2.25 per 100, less 40%.

Tap bolts, ½x1-in., $1.00 per 100. List plus 35% at New York warehouses.

Bolt ends, 1x12-in., 10c. per lb., less 40%.

Nuts, semi-finished, ¼x½-in., 2c. each. Discount 70% for $\frac{5}{16}$-in and smaller and 65% for ⅜-in. and larger.
Case hardened ¼x½-in., 6c. each, less 50%.

Rivets, button heads, ¾-in., ⅞-in., 1-in. diam. x2$\frac{1}{16}$-in. to 4$\frac{1}{16}$-in. $5.00* per 100 lb. at New York warehouses; cone heads, same sizes, $5.20* per 100 lb. Rivets, $\frac{1}{16}$x1-in. and longer, 19c. per lb., less 50%. Same discount for tinned. EXTRA per 100 lb. for 1¼ to 2-in. long, all diameters, 25c.; ⅜-in. dia., 35c.; ½-in. dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Washers, cast iron, ½-in., $7.00* per 100 lb. at New York warehouses; ⅝-in., $6.00* per 100 lb.

*For immediate delivery from warehouse.

Machine Requirements and Industrial Construction

Machine Tools and Equipment Wanted

Ala., Birmingham—The Stewart Machine Co., C. Stewart, Pres.—machinery including traveling cranes, drills, lathes, etc. for proposed machine shop at 9th Ave. and 26th St. Estimated cost $150,000.

Calif., Mountain View—Mountain View Union High School Dist.—equipment for proposed manual training shops. Estimated cost $55,000.

Ia., Council Bluffs—Haynes-Pollard Co., 2411 West Broadway—complete equipment for the manufacture of oil burning and automatic electrical refrigerator equipment.

Mich., Detroit—Llewellyn Steel Co., General Motors Bldg.—96 in. power shears for 16 gauge and lighter.

N. Y., East Aurora—Dalger Toothaker Shops—2 presses.

Pa., Oakmont—Edgewater Steel Co.—400-ton power press, one 400- and one 300-ton hydraulic presses, one hydraulic accumulator, 10 to 12 in. diameter.

Pa., Pittsburgh—U. S. Aluminum Co., Oliver Bldg.—24 in. heavy duty drilling machine and 24 in. cold saw tool room lathe for Cleveland plant.

Wis., Janesville—Russell Garage, 27 South Bluff St., repair shop machinery for proposed 2 story, 75 x 130 ft. garage. Estimated cost $60,000.

Wis., Sheboygan—Dillingham Mfg. Co., Wisconsin Ave. and South Water St.—additional equipment for the manufacture of household refrigerators.

Que., Montreal—Cutten & Foster, Ltd., 236 Sherbrooke St. W.—machinery, tools, etc., for proposed new automobile repair shop.

Opportunities for Future Business

Calif., San Francisco—American Brass & Bronze Works, 124 Juniper St., awarded contract for the construction of a 1 and 2 story addition to foundry at Juniper and Bryant Sts. Estimated cost $5,000.

Calif., San Francisco—City plans the construction of a car barn, repair and inspection shop on Potrero Ave. Estimated cost $200,000. M. M. O'Shaughnessy, City Hall, City Engr.

Calif., Santa Monica—Symphonaer Organ Co., 504 Wilshire Blvd., is having preliminary plans prepared for the construction of a factory. Estimated cost to exceed $250,000.

Conn., Southington—Peck, Stow & Wilcox Co., Railway Square, awarded contract for the construction of a 2 story, 97 x 100 ft. hardware shop. Estimated cost $65,000.

Ia., Cedar Rapids—P. M. Lattner Mfg. Co., 515 F. Ave., has work under way on the construction of a 2 story factory for the manufacture of steam and mill supplies. Estimated cost $40,000.

La., New Orleans—M. H. Goldstein, Hibernia Bank Bldg., Archt., will soon receive bids for the construction of a 5-story garage and wagon works on Gravier St. for J. Thomson & Bros., 233 South Rampart St. Estimated cost $100,000.

Mass., Watertown (Boston P. O.)—American Soda Fountain Co., Congress St., Boston, will receive bids until March 2 for the construction of a 2 story, 175 x 300 ft. factory on Walnut St. here. Estimated cost to exceed $150,000. Monks & Johnson, 99 Chauncy St., Boston, Archts. Noted Dec. 10.

Mass., Worcester—Mack Motor Truck Co., 75 North Beacon St., Boston, will soon award contract for the construction of a garage and repair shop on Shrewsbury St. here. Estimated cost $125,000. Warren Engineering Co., Terminal Wharf, Charlestown, Archt. and Engr. Noted Jan. 14.

What This Section Is

Machinery Requirements and Industrial Construction is a reliable machinery market, because every item is reported first-hand by our own correspondents, scattered over the United States and Canada. These leads are verified by our men. We do not use newspaper clippings, nor do we listen to any hearsay or rumors. These sales leads are as accurate as our men can make them, and as timely as weekly publication will permit.

This market is for *American Machinist* subscribers. It covers the same machinery fields as does the paper. Here will be found inquiries for machine tools, presses, hammers, welding, forging and heat treating equipment, wood working machinery, cranes, hoists and other material handling machinery for the shop.

Here also will be found reports of proposed industrial construction, where sooner or later machinery will be needed.

Are you making the most of the opportunities listed here?

Mich., Detroit—Packard Motor Car Co., East Grand Blvd., awarded contract for the construction of a 2 story, 131 x 147 ft. sales and service building on Hague Ave. Estimated cost $150,000. Noted Jan. 28.

Minn., Minneapolis—Strong-Scott Mfg. Co., 413 South 3rd St., flour and mill machinery, plans the construction of a 2 or 3 story factory on Taft St. Estimated cost $175,000. Architect not announced.

Mo., St. Louis—Burdeau Real Estate Co., 801 Chestnut St., will build a 1 and 2 story garage at Iron St. and Missouri Pacific R.R. Estimated cost $200,000. People's Motorbus Co., 583 Adelaide St., lessee. Noted Dec. 24.

Mo., St. Louis—Koken Co., 2528 Texas Ave., will build a 1 story, 100 x 160 ft. foundry on Morganford St. Estimated cost $50,000. Owner also plans the construction of a group of buildings for its barber supply factories. Estimated cost with equipment. $2,000,000.

Neb., Lincoln—J. L. Ludium, awarded contract for the construction of a 3 story, 191 x 314 ft. high school, including shops, etc. Total estimated cost $650,000.

N. J., Camden—E. E. Seelye & Co., 101 Park Ave., New York, N. Y., Archts., will receive bids until March 2 for the construction of a 1 story, 190 x 252 ft. service station at Sixth and Jefferson Sts. here for Mack International Motor Truck Corp., 741 Market St., Camden, N. J. Estimated cost $175,000.

N. Y., Brooklyn—A. Levine, c/o Magnuson & Kleinert, 250 Park Ave., New York, Archts., plans the construction of a 2 story garage, repair shop and sales and service station on Bedford Ave. Estimated cost $200,000.

N. Y., Buffalo—American Radiator Co., 1807 Elmwood Ave., is having plans prepared for the construction of a 1 story 100 x 300 and 100 x 330 ft. addition to malleable plant, also a 1 story, 80 x 300 ft. core plant. Estimated cost $100,000 and $45,000 respectively. L. A. Harding, 1335 Main St., Engr. Noted Jan. 28.

N. Y., New York—American Meter Co., 105 West 40th St., is having plans prepared for the construction of a plant at 563 West 47th St. Estimated cost $200,000. B. S. King, 18 East 41st St., Archt.

N. Y., New York—A. C. Chesley Co., 704 East 133rd St., plans the construction of a 2 story plant for the manufacture of metal doors, etc. Estimated cost $130,000. Architect not selected.

O., Columbus—J. E. McCrehen, 880 East Broad St., is having plans prepared for the construction of a 3 story, 100 x 100 ft. garage and stores building on South Fourth St. Estimated cost $200,000. Richards, McCarty & Bulford, 684 East Broad St., Archts.

O., Zanesville—J. K. Mercer is having plans prepared for the construction of a 2 story, 75 x 128 ft. garage on South Sixth St. Estimated cost $55,000.

Pa., Allentown—E. A. Krause, 519 Court St., awarded contract for the construction of a 1 story, 26 x 55 and 42 x 48 ft. garage on Seventh St. Estimated cost $40,000.

Pa., Bridgeville — Universal Steel Co., awarded contract for the construction of a 1 story, 100 x 160 ft. addition to manufacturing plant.

Pa., Clairton — Carnegie Steel Co., Carnegie Bldg., Pittsburgh, plans the construction of 300 additional by-product coke ovens here. Estimated cost $4,000,000. Private plans.

Pa., McKees Rocks—Enterprise Stamping Co., plans the construction of a 1 story, 100 x 236 ft. addition to manufacturing plant. J. H. Phillips, Wabash Bldg., Pittsburgh, Archt.

Pa., Pittsburgh—Crist & Schilker Co. Inc., 543 4th Ave., awarded contract for the construction of a 2 story, 75 x 100 ft. plant for the manufacture of metal products at 37th and Hawley Sts. Estimated cost $60,000.

Pa., Pittsburgh—Locomotive Stoker Co., 30 General Robinson St., is receiving bids for the construction of a 1 story, 30 x 180 ft. addition to plant on Robinson St. Hunting, Davis & Dunnello, Century Bldg., Archts. Noted Feb. 11.

Ont., Toronto—York-Adelaide Realty Co., York and Adelaide Sts., awarded contract for the construction of a 3 story, 100 x 200 ft. garage. Estimated cost $400,000.